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ENERGY AND WATER DEVELOPMENT APPROPRIATIONS FOR FISCAL YEAR 2004

WEDNESDAY, MARCH 12, 2003

U.S. SENATE,
SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS,
Washington, DC.

The subcommittee met at 2:32 p.m., in room SD–124, Dirksen Senate Office Building, Hon. Pete V. Domenici (chairman) presiding.

Present: Senators Domenici, Craig, and Dorgan.

DEPARTMENT OF ENERGY

OFFICE OF SCIENCE

STATEMENT OF DR. RAYMOND L. ORBACH, DIRECTOR

OPENING STATEMENT OF SENATOR PETE V. DOMENICI

Senator DOMENICI. The Senator from Nevada will probably be along shortly. Senator Craig, nice to have you here.

Today the subcommittee is going to review the Department of Energy's fiscal year 2004 budget request for, one, the Office of Energy Efficiency and Renewables, and the Office of Science and the Office of Nuclear Energy. In that regard, we will hear from Dr. David Garman, Assistant Secretary for Energy Efficiency and Renewable Energy. We will hear from Dr. Ray Orbach, Director of the Office of Science, and Mr. Bill Magwood, the Director of the Office of Nuclear Energy and Science Technology.

All of these witnesses have appeared before the subcommittee before and are well known to us. We look forward to your testimony today.

Let me summarize just a moment. It will not take me very long, Senator Craig, and then we will go right to the witnesses.

The budget request for renewable energy under Mr. Garman is $444 million, an increase of $24 million, about 6 percent over the current year. However, more than all of the increases put toward the President's initiative, an initiative that may displace much of our dependence on foreign oil in years to come, the so-called hydrogen research for the hydrogen car.

Under this subcommittee, we would more than double the amount spent for that endeavor to $88 million. Unfortunately, many of the traditional areas of renewable research, such as biomass, renewable research, geothermal and wind, are proposed to be cut. And that is below current levels in order to fund this initiative.

I am not sure that will hold. But somehow or another, we will work it out.

I continue to believe in the importance of the balanced portfolio. Our country must increase the diversity of energy production in order to reduce our dependence upon unstable sources of foreign energy. Under any scenario, renewable energy technologies will play a dramatic role in our energy future, recognizing the priorities of the administration, while continuing to address the priorities of many of the Senators on this subcommittee may prove to be a real challenge this year.

However, in addition to what we just talked about, the budget request for nuclear energy has elements of both good news and bad news. For me, the most notable new development, and Larry Craig, I think you would be interested in this, is the administration's request for $63 million to continue the advanced fuel cycle initiative. I am very pleased that someone, somehow, has worked through the Office of Management and Budget, and the Executive Branch has finally recognized that this is a truly long-term initiative of great significance. And the sooner we start, the sooner we will find out if and when it will be available as part of the nuclear cycle.

We have long believed that the country must move ahead to the next generation of fuel cells that generate less waste, extract full energy benefit from each gram of fuel. This is a long-term effort that requires a much larger investment by the Department.

Senator Reid and I have worked hard in our position of chairman and ranking member and vice versa in this effort the last few years. And to see the administration embrace the importance is truly gratifying.

Generally, the whole area of R&D is a mix of good news and some of bad news. The administration, with much help from this subcommittee, has begun to correct many years of neglect. The Department has now in place the structure of a well thought-out R&D program and addresses the near-term goal of bringing a new plant online through nuclear power in 2010 while performing the R&D necessary for nuclear power to support growing demand for worldwide electricity over the next 50 years, a Generation IV program and advanced fuel cycle initiatives.

However, the request is not all good news, as the Department proposes the elimination of new funding for the Nuclear Energy Optimization Program. And perhaps you will address that for us a bit. I know you work for the administration. Nonetheless, we would appreciate your evaluation for us as to what that does to the program; that is the program of continued and maximum use of nuclear power plants.

Finally, the budget request for the Office of Science, it is only a little better than flat for the coming year. The Department of Energy is the Federal Government's largest supporter of physical science. And as such, I remain concerned about the tremendous imbalance in the Government's investment in physical sciences versus life sciences. NIH's budget has doubled in 5 years, while DOE's science can probably claim and prove that it has been slightly higher than inflation.

PREPARED STATEMENTS

Past successes in biomedicine have been built upon the strong foundation of the physical and computational sciences that are present in DOE. However, we will not be equipped to take advantage of these remarkable new opportunities in genomics, nanotechnology, and advanced materials and other areas unless we increase the funding for DOE science.

The rest of my statement can be made a part of the record. Senator Cochran has a statement. It will be made a part of the record immediately following mine.

[The statements follow:]

PREPARED STATEMENT OF SENATOR PETE V. DOMENICI

Today, the Subcommittee will review the Department of Energy's fiscal year 2004 budget request for the Office of Energy Efficiency and Renewable Energy; the Office of Science; and the Office of Nuclear Energy.

In that regard, we will hear from Mr. David K. Garman, Assistant Secretary for Energy Efficiency and Renewable Energy; Dr. Ray Orbach, Director of the Office of Science; and Mr. Bill Magwood, Director of the Office of Nuclear Energy, Science and Technology.

All of the witnesses have appeared before the subcommittee before and are well known to us. We look forward to your testimony today.

This is the Subcommittee's second hearing this year but our first opportunity to review the Administration's budget request for the Department of Energy. Overall, the Administration is seeking $21.7 billion for programs and activities of the Department within the jurisdiction of this subcommittee. That is a $785 million increase over the current year enacted level of $20.89 billion (or approximately 4 percent).

That increase appears reasonable, but it must be viewed in its proper context. Almost all of the increases for the Department occur in the nuclear weapons and nonproliferation programs of the NNSA, in the Department's environmental clean-up programs, and in proposed funding for the Yucca Mountain project.

The programs we are reviewing today, which make up just over $4 billion of the Department's budget, would increase by less than inflation, or 2 percent over the current year enacted level.

The budget request for renewable energy research under Mr. Garman is $444 million, an increase of $24 million (6 percent) over the current year level. However, more than all of the increase is put toward the President's exciting hydrogen initiative that may displace much of our dependence on foreign oil by 2020. Hydrogen research under this subcommittee would more than double to $88 million in fiscal year 2004.

Unfortunately, many of the traditional areas of renewable research, such as biomass, geothermal and wind, are proposed to be cut below current year levels in order to fund the President's agenda.

I continue to believe in the importance of a balanced energy portfolio. Our country must increase our diversity of energy production in order to reduce our dependence on unstable foreign sources of energy. Under any scenario, renewable energy technologies will play a dramatic role in our energy future. Recognizing the Administration's priorities while continuing to address the priorities of many Senators on this subcommittee may prove to be a real challenge this year.

Likewise, the budget request for Nuclear Energy has elements of both good news and bad news. For me, the most notable new development is the Administration's request for $63 million to continue the Advanced Fuel Cycle Initiative.

I have long believed that the country must rapidly move ahead with a next-generation fuel cycle that generates far less waste and extracts the full energy benefit from each gram of fuel. This is a long-term effort that requires a much larger investment by the Department. Senator Reid and I have worked hard to sustain this effort for the last several years and I am pleased to see the Administration embrace this important initiative.

I am generally encouraged with the progress in nuclear R&D. The Administration, with much help from this subcommittee, has begun to correct many years of neglect. The Department now has in place the structure of well-thought-out nuclear R&D program that:

—addresses the near-term goal of bringing a new plant on line through the Nuclear Power 2010 program;
—while performing the R&D necessary for nuclear power to support the growing demand for electricity world-wide over the next 50 years through the Generation IV Program and the Advanced Fuel Cycles Initiative.

However, the request is not all good news, as the Department proposes elimination of new funding for the Nuclear Energy Plant Optimization program and a 50 percent cut to the well regarded Nuclear Energy Research Initiative. We will address these concerns and others as best we can.

Finally, the budget request for the Office of Science remains only a little better than flat for the coming year.

The Department of Energy is the federal government's largest supporter of physical sciences. As such, I remain concerned about the tremendous imbalance in the government's investments in the physical sciences verses the life sciences. For example, NIH's budget has doubled in 5 years while DOE Science cannot even keep up with inflation.

Past successes in biomedicine have been built upon the strong foundation of the physical and computational sciences. However, we will not be equipped to take advantage of remarkable new opportunities in genomics, nanotechnology, advanced materials, and other areas unless we increase funding in DOE Science.

Each of the program areas before us today will present unique challenges and opportunities for this subcommittee. I will look forward to engaging each of our witnesses today and working with the Senator Reid and the members of the Subcommittee to put together the best possible bill.

I will yield now to Senator Reid and any other Senator that would like to make an opening statement.

Thereafter, we will hear from Mr. Garman, Dr. Orbach, and finally Mr. Magwood.

PREPARED STATEMENT OF SENATOR THAD COCHRAN

Mr. Chairman, I'd like to thank the Undersecretary and Directors for testifying before this committee today. The work you do is very important to my state and to me. I'd like to commend David Garman, the Director of the Office of Energy Efficiency and Renewable Energy, for the work he does with biomass research.

This scientific research is so important to a rural, agricultural state like Mississippi. Biomass energy is estimated to contribute over 7 percent of Mississippi's total energy consumption—that amount is double the national average. The majority of our lumber facilities burn wood waste to generate steam for industrial processes. Biomass offers special opportunities for benefitting Mississippi's economy by keeping energy dollars in our state and by providing jobs in rural areas where biomass is produced. By using their wastes for energy, disposal costs are avoided, and industries are better able to compete.

The principal biomass waste streams that occur in Mississippi are generated by agriculture (e.g., cotton gin waste), wood products manufacturing (e.g., sawdust and wood scraps), animal wastes from confined feeding operations, and municipal solid waste collections (e.g., paper and cardboard, demolition waste, lawn and tree trimmings).

Last year I visited a biomass plant in Winona, Mississippi and inquired about plans for using federal funds that were appropriated in the fiscal year 2003 omnibus bill. I learned that the Winona biomass project can enter its final stages of discovering the organism which will cause the heated biomass to turn into gas. Once that organism or "bug" is discovered, the plant can operate from start to finish where chips of wood can be input, burned and then gasified into ethanol. In a town like Winona, that sort of success has great economic development potential.

I am pleased to learn that the Department is concentrating its biomass research efforts on the catalysts needed for biomass gasifiers. Many communities, beyond the scientific community, will benefit from this work.

I would also like to commend the Mississippi Diagnostic Instrumentation and Analysis Laboratory at Mississippi State University. I am pleased to see that you're funding good science, like the joint Los Alamos-Mississippi State project that we hope will be useful for both DOE and Homeland Security. A continuing concern is how do we take this magnificent science and turn it into the new technologies DOE needs to accelerate cleanup. I am hopeful that you consider using organizations such as DIAL at Mississippi State to turn your science into technologies that will be used at the DOE sites.

Mr. Chairman, with your permission I have a question I'd like to submit for the record.

Senator DOMENICI. And I yield now to Senator Larry Craig for his comments. And then we will take the witnesses.

Senator Craig.

STATEMENT OF SENATOR LARRY CRAIG

Senator CRAIG. Well, thank you, Mr. Chairman. I will be brief. And I do appreciate a chance to speak now. I have to pull out about 3:00 to attend something else.

But first of all, I want to visit Bill Magwood. We have been working very closely since Secretary Abraham announced that the INEEL and Argonne-West would be DOE's lead lab for nuclear energy. And certainly the chairman has been a leader in advancing this cause for some time. He spoke to it a few moments ago.

But I do appreciate the hard work that you have put into the transition at the Idaho National Engineering Environmental Laboratory and the new mission that we are talking about. I have looked at the administration's budget request for nuclear, and I am pleased by what is there. It is much improved. The chairman just mentioned it. The previous administration had pretty much zeroed things out. If we are going to advance the cause of nuclear in the next generation, we have to get at it. You are getting at it, and we appreciate that.

Obviously last year, the Chairman and I met with you, the Vice President, Secretary Abraham. And we talked about Generation IV reactor development, to get it beyond the design or the study on papers to the actual step forward. And clearly, that is what we are about now. And we thank you for that. And, Mr. Chairman, I lay a great deal of the effort to your credit for the work you have done there.

But we must keep trying to fix the Argonne layoff situation. It is unacceptable to do it, if we are going to try to grow nuclear. You do not fire one year and hire the next year, when you have top quality scientists on board ready to go. And that is really an issue that I think has to get resolved as we move forward.

Dr. Orbach, I do appreciate your presence. I have read your testimony. Although the Office of Science program does not have a large presence in Idaho, you are doing a lot of extremely valuable work. I want to highlight one area, and that is fusion energy. Yesterday I introduced the Fusion Development Act of 2003. Senator Dianne Feinstein and I have worked cooperatively on that as cosponsors. President Bush has been focused on the movement of this Nation in a clean, sustainable hydrogen economy. That is certainly important.

We have invested a fair amount in it so far, and we are a ways down the road toward that. Obviously, continued development and infrastructure become a major hurdle to overcome. The President has acknowledged that fusion energy, if we can make it practical and affordable, will be one of the ways to get us to that hydrogen future. The other way is, obviously, nuclear energy. And I will be working on that front as well, as we work to craft this bill.

David, it is great to have you back before us. Between this committee and the Energy Committee, we have been seeing you quite often here on the Hill. And that is always appreciated. The work

you have done in the past year and of course the work you did for Senator Murkowski is well recognized.

We also had you recently on a visit to Idaho. And I appreciate your effort to take the time to better understand what we do out there and the kind of work that goes on. And while you were there, I suspect you heard us talk about some agriculture and some bioenergy initiatives.

The issue that the Governor, while Senator, worked with me on was fish-friendly turbines. They say it cannot be done. And while some of our friends do not like to admit it, the adjustment and the management of the Snake and the Columbia River systems is beginning to establish record fish runs. We have clearly stopped the decline in five of these critical species. And there is now movement upward. And part of that is beginning to understand, manage the river, retrofit many of these hydro facilities with fish-friendly turbines. That work began at Bonneville. It is working upriver. And it is critically important to the West, to all of us, and to the fisheries of our country.

So thank you very much for being here. We look forward to your testimony.

Mr. Chairman, thank you.

PREPARED STATEMENT OF SENATOR HARRY REID

Senator DOMENICI. Thank you, Senator.

Senator Reid's statement will also be made a part of the record.

[The statement follows:]

PREPARED STATEMENT OF SENATOR HARRY REID

Thank you, Mr. Chairman. I am glad to see that you are feeling a little better than you did last week. Senator Cochran filled in nicely for you at the hearing, but we all missed you.

Today is the second in a series of five budget oversight hearings for the Energy and Water Development Subcommittee. Last Wednesday, the Subcommittee heard testimony from the Bureau of Reclamation and the U.S. Army Corps of Engineers.

Today we will hear from three witnesses:

—Dr. Raymond Orbach, the Director of DOE's Office of Science;

—Mr. Bill Magwood, the Director of the Office of Nuclear Energy; and

—Mr. Dave Garman, the Assistant Secretary for the Office of Energy Efficiency and Renewable Energy.

Good afternoon, gentlemen, thank you for coming. Senator Domenici and I both appreciate you taking the time to join us. My duties on the Floor may require me to depart early today, but my staff will remain here and will report back on what transpires. I do have a series of questions for each of you and would ask, at this time, that they be made a part of the record. I hope each of you can respond quickly because the Chairman and I rely on your answers to help us make informed funding decisions.

I plan to keep my comments very brief today, but do want to highlight several issues concerning the budget requests for each of the three DOE offices represented today.

Dr. Orbach, I have reviewed the budget for the Office of Science and, by and large, I suspect that you and I share some of the same frustrations with it. The administration's budget request provides your office with a mere 1.4 percent increase. While I am somewhat comforted by the notion that the ramp-down in construction funding for the Spallation Neutron Source actually allows a research budget increase of closer to 4.5 percent, my overall impression is that the request is weak and shortsighted.

I hope that we are able to improve on that a little bit before Congress completes work this year. As I have said many times before, funding for research in the hard sciences is one of the very best and most appropriate investments of taxpayer dol-

lars that Congress can make. Very few things that we do here can make our country safer or more secure than maintaining a scientific and technological edge.

For many years now Chairman Domenici and I have watched as the last two administrations have sent ever-escalating budget requests up here for the National Institutes of Health that have far outstripped the increases requested for the Office of Science. The imbalance between funding for the physical science and the biological sciences was getting to be staggering, particularly because both disciplines rely on each other so much.

This year, the disparity has lessened, but not in the way I had hoped. Rather than the usual 14–15 percent increase for NIH, the administration has chosen to request an additional 7–8 percent. Again, over the long-term, this is very short-sighted.

I am, however, pleased that the administration has decided to take the long view on another important international effort, though. Earlier this year, the administration announced that the United States would re-join the international burning plasma fusion program, the so-called ITER project. This was a wise decision that I hope will be followed-up with robust budget requests.

I am also very pleased with the work you are doing on the Genomes to Life Program and with the impressive pace of the nanotechnology program.

You have been on the job now for nearly a year to the day and I hope you are enjoying your time in one of the greatest jobs our Federal Government has to offer.

Mr. Garman, my guess is that we are going to hear a lot from you on the subject of hydrogen today. The administration's initiative has certainly gotten a lot of attention, both positive and negative.

My inclination is to try to be as supportive as possible. I am pleased that the administration has decided to tackle a big, long-term renewable energy effort to complement the shorter-term focus on the deployment of promising technologies that dominates much of the rest of your budget.

My staff has been talking to me about the potential of the "hydrogen economy" for years, so I want to help as best I can. Obviously, the devil will be in the details in how this program comes together, but those are details that we can work out as we move forward.

One immediate concern that I do have is that it appears that you cut many of your other programs in order to accommodate the increases for hydrogen. Particularly hard-hit is your geothermal program, which is down $16 million.

I realize that you were probably told to go find the additional dollars for hydrogen at the very last minute, long after you thought your budget had been put to bed, but ultimately, your overall portfolio must be balanced.

Good luck as you move forward.

Mr. Magwood, as you know I have been very supportive of your programs during my years as Chairman and Ranking Member of this Subcommittee. I am supportive even though it sometimes puts me in an awkward spot due to that very visible word "nuclear" in your office's title.

I support strong budgets for you because, as I mentioned earlier, long-term, stable, investments in scientific research and development is what makes our Nation strong.

My biggest problem with nuclear power comes at the end of the fuel cycle. However, I firmly believe that investments in the future of nuclear power can produce reactors that are safer and will not produce the deadly waste streams that plague the current generation of reactors.

To the extent that there will be an on-going waste stream, it will be investments in the science that solves all or most of the disposal problem.

This is why I am pleased that your Advanced Fuel Cycle Initiative seems to be coming along nicely. Senator Domenici and I both have been interested in transmutation of waste for years, so we are both pleased that the Department is preparing to invest some resources in this area.

I need to be careful not to steal too much of Chairman Domenici's thunder in talking about what I know to be one of his favorite programs, so I will stop here.

Again, thanks to our witnesses for appearing today.

Senator DOMENICI. Let us proceed then with the witnesses. Let us start with Dr. Orbach.

STATEMENT OF RAYMOND L. ORBACH

Dr. ORBACH. Thank you, Mr. Chairman.

Senator DOMENICI. You are welcome.

Dr. ORBACH. I would like to thank you and the members of the committee for your support for the Department of Energy and specifically the Office of Science. This is the beginning of my second year now as director. And I have enjoyed my relationship with you very much.

I hope I can submit my testimony for the record and just make a few comments and introductions.

The investment of basic research of the Office of Science supports the work of more than 8,000 researchers and students at more than 250 universities and Department of Energy laboratories. This year we reached 18,000 users of our facilities. Our budget, as we have submitted it to you, is roughly half for the operation of those facilities, and then the other half for the research that is carried out across the country, and indeed the world. That half is about equally divided between universities and laboratory personnel.

We support as much research in the universities as we do in the laboratories. All of that, both the components for university and laboratories, are competed together with the peer review process, so that everybody has an equal chance at funding. Just because someone is in a research laboratory does not mean that they have an advantage over anyone else.

The Office of Science is privileged to be responsible for these large facilities. We think we complement the national effort because of our commitment to long-term funding, high risk with high payoff, and multidisciplinary teams.

Just to comment on our highlights of the budget, the areas that are priorities for the Office of Science; Senator Craig, as you have noticed, we have joined ITER now as a partner. We are pleased to take our place as a partner in this very important development. The consequences of fusion energy are recognized in the National Energy Policy on an abundant and clean source of energy.

High-performance computation remains a high priority. This budget contains $14 million to begin looking at different architectures so that we can find the structures that will enable us to solve major problems, scientific discovery through simulation and computation. We are working now with three, and we hope four, vendors to try their structures out on real science problems that we want to solve.

The Spallation Neutron Source, which will be the leading source for neutron science in the world for at least a decade or more, now that Europe has decided not to go in this direction, is well under way and on track and on budget. We look forward to that operation giving the United States primacy again in neutron science.

Four of our five nanotechnology centers currently are contained within the fiscal year 2004 budget. Nanotechnology is an opportunity that the Office of Science is pursuing aggressively. We are pleased that our scientists will have access to these world-class facilities that are nowhere else found but in the United States.

The life sciences, the Genomes to Life program is proceeding well. I want to thank you, Mr. Chairman, for your support for this program. We are now expanding it to produce the energy requirements that this country faces and also to help with carbon sequestration.

Finally, in this budget there is a new initiative for teacher education, for workforce development. We have a line item that will enable us to bring, on a pilot basis, teachers to our laboratories where we will work with them during the summer and then follow up in their classroom, providing support for them.

A program like this used to exist in the mid-1990's, and we are anxious to begin it again. We have quantitative evidence that the students whose teachers have gone through this program fare much better on examinations in both science and mathematics than a comparable category, a control group, of students whose teachers had not experienced these opportunities.

We have had some major accomplishments this year. We are very proud of Mr. Raymond Davis, Jr., for receiving the Nobel Prize in physics for his work on neutrinos. I think it marks the beginning of development in cosmology where we will be working at the very small in order to predict the behavior of the very large. Mr. Davis' citation from the Nobel Committee points that out as the beginning of the relationship between the experiments we do here on Earth and what we observe at the very large.

Finally, we have, through our materials program and our nanotechnology program, been able to accomplish something I think that all of us should take pride in, and that is restoring sight. We have been able to implant a small chip in the retina of a person who lost their sight over 30 years ago. By use of our materials sciences—this is not a simple task to keep electrical contacts stable in the vitreous humor of the eye—that person was able to see.

So far, we are operating only at a small number of pixels, only 16. But we have underway a 1,000-pixel implant, which will enable a person who was blind to read a large-print newspaper. Over 200,000 Americans each year suffer from retinal disease. This program, we hope, will combine the material science characteristics of the Office of Science with the medical profession, showing again how the physical sciences can aid the medical profession in accomplishing their goals.

PREPARED STATEMENT

This is a great opportunity for us to present our programs to you. I want to thank you again for your support. This concludes my testimony. I will be pleased to answer questions.

Thank you.

Senator DOMENICI. Thank you very much. Your statement will be made a part of the record.

[The statement follows:]

PREPARED STATEMENT OF RAYMOND L. ORBACH

Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to testify today about the Department of Energy's (DOE) Office of Science fiscal year 2004 budget request. I am deeply appreciative of your support for basic research, Mr. Chairman, and the support we have received from the other Members of this Subcommittee. I am confident that our fiscal year 2004 request represents a sound investment in our Nation's future. Through this budget we will strengthen core research programs, increase operating time at major scientific user facilities, and expand our capabilities for the future.

This budget requests $3,310,935,000 for the fiscal year 2004 Science appropriation, an increase of $47,059,000 over fiscal year 2003 (see Figure 1), for investments

in: Advanced Scientific Computing Research (ASCR), Basic Energy Sciences (BES), Biological and Environmental Research (BER), Fusion Energy Sciences (FES), High Energy Physics (HEP), Nuclear Physics (NP), Science Laboratories Infrastructure, Safeguards and Security, Workforce Development and Science Program Direction.

These investments in basic research directly support the work of more than 8,000 researchers and students at more than 250 universities and at DOE's national labs. In addition, another 18,000 researchers annually take advantage of the major scientific user facilities operated on behalf of the Nation. The Office of Science is the steward of 10 national laboratories, which conduct and collaborate on the multi-disciplinary research that is essential to providing sustained progress toward the most difficult scientific questions and to ensuring that our Nation is able to respond rapidly in times of need.

These researchers will advance the frontiers of nanoscale science; pursue the key questions at the intersection of physics and astronomy identified by the National Academy of Sciences; develop the knowledge base for bringing genomes to life with the potential to harness microbes and microbial communities to improve energy production and environmental remediation; advance the goals of the Administration's Climate Change Research Initiative and the National Energy Policy; begin negotiations to participate in the international fusion project—ITER; develop a new generation of computing architecture to identify and address performance bottlenecks in existing and planned systems; and bring the full potential of scientific computation to bear on the Department's scientific problems.

The Office of Science is the single largest supporter of basic research in the physical sciences, providing approximately 40 percent of all Federal funds in this area over the past decade. It is also the steward, and by far the principal funding agency, of the Nation's research programs in high energy physics, nuclear physics and fusion energy sciences, as well as being the Federal government's largest source of support for materials and chemical sciences. The Office of Science also supports unique or critical pieces of U.S. research in scientific computation, climate change, geophysics, genomics, and the life sciences.

Research projects supported by the Office of Science are selected on the basis of peer review and evaluation for quality, relevance and performance as emphasized in the President's Management Agenda and R&D Investment Criteria. These diverse and multidisciplinary programs rely upon the advice of the scientific community in developing daring and innovative research directions and facility capabilities. As a result, the program oversees one of the strongest research portfolios in the world—a strategic investment in the future technological strength and agility of the Nation.

The Council on Competitiveness noted in its report Competitiveness 2001, Strengths, Vulnerabilities and Long Term Priorities, that, "Given the rising bar for competitiveness, the United States needs to be in the lead or among the leaders in every major field of research to sustain its innovation capabilities." Beginning with the impact on technology development of scientific discoveries in chemistry and electromagnetism at the end of the 19th century, scientific discovery has become the source of new technologies that are critically important to economic progress, energy and national security. We are in a period of rapid technological change. Advances in computing, communications and scientific instruments—many of them developed by SC—have transformed our society including the conduct of science. As a result, there are new scientific opportunities today that promise revolutionary technologies to come.

FIGURE 1.—OFFICE OF SCIENCE FISCAL YEAR 2004 PRESIDENT'S REQUEST

(B/A in Thousands)

	Fiscal Year 2002 Approp.	Fiscal Year 2003 President's Request	Fiscal Year 2004 President's Request
Advanced Scientific Computing Research	150,205	166,557	173,490
Basic Energy Sciences	979,560	1,019,163	1,008,575
Biological and Environmental Research	[1] 554,125	484,215	499,535
High Energy Physics	697,383	724,990	737,978
Nuclear Physics	350,589	382,370	389,430
Fusion Energy Sciences	241,100	257,310	257,310
Science Laboratories Infrastructure	37,125	42,735	43,590
Science Program Direction	149,467	137,332	150,813
Workforce Development	4,460	5,460	6,470
Safeguards and Security	45,770	43,744	43,744

FIGURE 1.—OFFICE OF SCIENCE FISCAL YEAR 2004 PRESIDENT'S REQUEST—Continued

(B/A in Thousands)

	Fiscal Year 2002 Approp.	Fiscal Year 2003 President's Request	Fiscal Year 2004 President's Request
SBIR/STTR	[2] 99,668	.....	.....
Total Office of Science	3,309,452	3,263,876	3,310,935

[1] Includes $68,822,000 of one time projects.
[2] Includes $36,391,000 from other programs.

FISCAL YEAR 2004 SCIENCE PRIORITIES

The fiscal year 2004 request supports major research programs that respond to DOE priorities and will contribute to the strength and vitality of the national research enterprise. Many of these research programs are conducted jointly with other Federal agencies and are illustrative of the wide array of scientific talent and resources that DOE brings to bear on critical national challenges:

—Enter negotiations with representatives of the European Union, Japan, Russia and other international partners on construction and operation of a burning plasma experiment—the International Thermonuclear Experimental Reactor (ITER).

—Continue to build on its leadership in high performance computing and networking to bring the full potential of scientific computation to bear on the Department's scientific and technical challenges. It will initiate a Next Generation Computer Architecture program to identify and address performance bottlenecks in existing and planned systems.

—Continue construction of the Spallation Neutron Source, proceed with construction of three Nanoscale Science Research Centers (NSRCs) and initiate work on two others. These NSRCs—located at national laboratories in New York, Tennessee, Illinois, New Mexico and California—will provide scientists with an unmatched set of tools to design and build complex nanoscale materials.

—Exploit its unique capabilities at the intersection of the physical sciences, the life sciences and scientific computation to continue and expand its effort to understand how the instructions embedded in genomes control the development of organisms, with the goal of harnessing the capabilities of microbes and microbial communities to help us to produce energy, clean up waste, and sequester carbon from the atmosphere.

—Initiate a Laboratory Science Teacher Professional Development program for K–14 teachers in science and mathematics. Teachers will be competitively selected for a 4–8 week mentoring program by both scientists and master teachers at a national laboratory, followed by both additional 1 week mentoring visits and long term continuing support.

—Exploit the capabilities of the world's finest set of research facilities in particle physics to attempt to find the answers to questions about matter and energy at the most fundamental level. What gives elementary particles their great variety of masses? Are there extra dimensions of space beyond the three we know? Why is there so little antimatter in the universe when we expect equal amounts of each were created in the Big Bang? What is the Dark Energy that causes the recently observed acceleration in the expansion of the universe and comprises fully two thirds of the mass and energy budget of the universe? What were the properties of the early universe before quarks and gluons condensed into protons and neutrons?

SCIENCE ACCOMPLISHMENTS

The Office of Science can trace its roots to the original legislation creating the Atomic Energy Commission in 1947, which had a charter to use fundamental research in nuclear physics and other physical sciences towards ". . . improving the public welfare, increasing the standard of living, strengthening free competition in private enterprise, and promoting world peace." More than five decades later, the Office of Science can point to an extraordinary and diverse array of scientific discoveries that have led to dozens of Nobel Prizes, a draft map of the Human Genome, the creation of "Bucky Balls," discovery of the quark structure of matter and the "Accelerating Universe," major breakthroughs in medical diagnoses and nuclear medicine, and providing tools that allow researchers to "see" at the atomic and sub-

atomic scales, to simulate complex interactions and to collaborate across great distances.

That history of discovery (which is documented on the Office of Science website, www.er.doe.gov/feature__articles__2001/June/Decades/index.html) continues to this day, with major accomplishments in the past year that are the result of our long-term, high-risk, multidisciplinary research and strong management practices.

Two achievements in 2002 stand out as representative of the scope and magnitude of the research sponsored by SC. First is a technological miracle—restoring sight to the blind—being developed through an extraordinary marriage of biology and the physical sciences. The combination of diverse scientific disciplines such as these is a hallmark of Office of Science research and a particular strength of the DOE national laboratories. But realizing this remarkable technology also relies on the unique capabilities of industry (Second Sight, located in Santa Clarita, Calif.) and academia (the Doheney Eye Institute at the University of Southern California and North Carolina State University) in partnership with the national laboratories. In this project, specially designed MEMs (microelectro-mechanical systems) electrodes are positioned on the retinas of patients who have been blinded by disease, enabling them to convert light to electrical pulses that are received by the brain. Today's prototype enables a formerly blind patient to distinguish light from dark. Tomorrow's technology has the potential to restore almost full sight to the 200,000 people in the United States who are blinded every year by macular degeneration. This miracle of science is possible due to the long-term commitment of dedicated teams of scientists supported by DOE.

The second was the award of the 2002 Nobel Prize for Physics shared by Raymond Davis, Jr., whose sublime experiments led to the capture of solar neutrinos, proving that fusion provides the Sun's energy and leading to the creation of an entirely new field of research: neutrino astronomy. Davis did his groundbreaking work while a researcher at DOE's Brookhaven National Laboratory, which is home to multiple Nobel Prize recipients. This is the most recent of the Nobel Prizes that have been awarded to DOE-supported scientists.

In its announcement, the Royal Swedish Academy of Sciences said of Davis's accomplishment: "This year's Nobel Laureates in Physics have used these very smallest components of the universe (neutrinos) to increase our understanding of the very largest: the Sun, stars, galaxies, and supernovae. The new knowledge has changed the way we look upon the universe."

SCIENCE PROGRAMS

ADVANCED SCIENTIFIC COMPUTING RESEARCH

Fiscal Year 2002 Appropriation—$150.2M; Fiscal Year 2003 Request—$166.6M; Fiscal Year 2004 Request—$173.5M

The Advanced Scientific Computing Research (ASCR) program underpins DOE's ability to accomplish its mission through scientific computation. The ASCR program supports research in applied mathematics, computer science and high-performance networks and provides high-performance computational and networking resources to enable the advancement of the leading edge science that the DOE mission requires. ASCR delivers the power of advanced scientific computation and networking to the wide array of scientific disciplines supported by SC.

In fiscal year 2004, ASCR will embark on research to identify, address and correct bottlenecks that presently constrain DOE's capabilities in modeling and simulation. A research portfolio in Next Generation Computer Architecture will be initiated to assess novel computer architectures and their prospects for achieving optimal performance for cutting-edge scientific simulations.

In fiscal year 2004, the ASCR program will continue to develop the underlying mathematical algorithms, software building blocks and infrastructure for the "Scientific Discovery through Advanced Computing," (SciDAC) program. SciDAC is an Office of Science research endeavor to produce the scientific computing, networking and software that DOE researchers will need for sustained progress at the scientific forefront in areas of strategic importance to the Department. The scope of the SciDAC program will be extended to include new activities to address the urgent need for a quantitative understanding of matter at the nanoscale.

The ASCR program will also maintain the vitality of its basic research efforts in applied mathematics, computer and computational science, and network research to bolster the foundation for continued success in advancing scientific frontiers through computation.

In fiscal year 2004, the Genomes to Life research activities in partnership with Biological and Environmental Research will be expanded to include new research

in the applied mathematical sciences that will enable new computational techniques for the study of regulatory networks and metabolic pathways for microbial systems.

Finally, in fiscal year 2004, ASCR will provide high performance computing and networking resources at the levels needed to meet Office of Science needs. The National Energy Research Scientific Computing Center, as a result of an enhancement in fiscal year 2003, will be operated at 10Tflops to meet the computational needs of nearly 2,400 users. ESnet will be operated to provide state-of-the-art network services and capabilities to DOE-supported researchers nationwide to collect, analyze, visualize and distribute large-scale scientific data sets.

BASIC ENERGY SCIENCES

Fiscal Year 2002 Appropriation—$979.6M; Fiscal Year 2003 Request—$1,019.2M; Fiscal Year 2004 Request—$1,008.6M

The Basic Energy Sciences (BES) program is a principal sponsor of fundamental research for the Nation in the areas of materials sciences and engineering, chemistry, geosciences, and bioscience as it relates to energy. This research underpins DOE missions in energy, environment, and national security; advances energy related basic science on a broad front; and provides unique user facilities for the United States scientific community.

In fiscal year 2004, construction will proceed on three Nanoscale Science Research Centers (NSRCs), project engineering design will be initiated on the fourth NSRC, and a Major Item of Equipment will be initiated for the fifth and final NSRC. NSRCs are user facilities for the synthesis, processing, fabrication, and analysis of materials at the nanoscale. The five NSRCs will be located strategically at national laboratories across the country in New York, Tennessee, Illinois, New Mexico, and California. These facilities, in conjunction with existing user facilities at these national laboratories, will provide a strikingly unique suite of forefront capabilities where the Nation's leading scientists can design and build complex nanoscale materials all in one place.

The five NSRCs will be the Nation's critical focal points for the development of the nanotechnologies that will revolutionize science and technology. They will provide state-of-the-art nanofabrication equipment and quality in-house user support for hundreds of visiting researchers. The Centers will provide an environment for research of a scope, complexity, and disciplinary breadth not possible under traditional individual investigator or small group efforts. As such, the DOE Centers will be the training grounds of choice for the top graduate students and elite postdoctoral associates who will lead the future of scientific research.

A high priority in fiscal year 2004 is continued construction of the Spallation Neutron Source (SNS) to provide the next-generation, short-pulse spallation neutron source for neutron scattering. The project, which is to be completed in June 2006, is on schedule and within budget with over half of the work completed as of the end of fiscal year 2002. At the end of fiscal year 2004, construction of the SNS will be 80 percent complete.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

Fiscal Year 2002 Appropriation—$554.1M; Fiscal Year 2003 Request—$484.2M; Fiscal Year 2004 Request—$499.5M

Today, we have unprecedented opportunities to use advances in biology, computation, engineering, physics, and chemistry, to develop new solutions for challenges in energy, the environment, and health. The Biological and Environmental Research (BER) program is bringing these diverse fields together at DOE laboratories, universities, and private research institutes to find innovative approaches to address DOE challenges.

In fiscal year 2004, the Genomes to Life program continues to develop novel research and computational tools that, when combined with our genomics, structural biology, and imaging research provide a basis to understand and predict responses of complex biological systems. Other BER efforts in the Life Sciences include Human Genome research and DNA sequencing and Low Dose Radiation research.

BER contributions to the President's Climate Change Research Initiative include research in climate modeling, atmospheric composition, and regional impacts of climate change. Carbon cycle research will work toward understanding what fraction of carbon dioxide emissions are taken up by terrestrial ecosystems. New in fiscal year 2004 are ecological research efforts to begin to bridge the knowledge gap between molecular level effects and the responses of entire ecosystems to natural and human-induced environmental changes.

A key challenge in Environmental Remediations Science is to understand the subsurface environment and to then develop innovative options for clean up and protec-

tion. In fiscal year 2004, BER research will continue to develop new cleanup strategies, including bioremediation of metals and radionuclides and the treatment and disposal of high-level radioactive wastes stored in large underground tanks. The Environmental Molecular Sciences Laboratory is maintained at the leading edge of computational capabilities for enhanced modeling of environmental and molecular processes.

Because of DOE's diverse capabilities across a range of scientific disciplines, BER Medical Applications research will continue to provide the medical community with novel devices and technologies to detect, diagnose, and treat disease. One example is research that will develop the capability to detect genes as they are turned on and off in any organ in the body with enormous impacts in developmental biology and the diagnosis of disease.

FUSION ENERGY SCIENCES

Fiscal Year 2002 Appropriation—$241.1M; Fiscal Year 2003 Request—$257.3M; Fiscal Year 2004 Request—$257.3M

The Fusion Energy Sciences (FES) program leads the national research effort to advance plasma science, fusion science, and fusion technology—the knowledge base needed for an economically and environmentally attractive fusion energy source. The National Energy Policy states that fusion power has the long-range potential to serve as an abundant and clean source of energy and recommends that the Department develop fusion. It is the consensus of fusion researchers worldwide that the next frontier in the quest for fusion power is the creation and study of a sustained, burning (or self-heated) plasma. The Fusion Energy Sciences Advisory Committee (FESAC) has concluded that the fusion program is ready to proceed and has recommended joining the ongoing negotiations to construct the international burning plasma experiment, ITER, a strategy endorsed by the National Research Council (NRC) of the National Academy of Sciences. Following these recommendations, and an Office of Science reviewed cost estimate for the construction of ITER, the Administration decided to join the ITER negotiations.

To be successful, the ITER negotiations must resolve not only citing of the project and an agreed-upon financial and procurement arrangement, but also satisfactory management and oversight arrangements. In these negotiations, the United States will strive for a robust management structure and an oversight program based on the principles of equity, accountability and transparency to ensure both the success of the project and the best use of taxpayer dollars.

In light of the Administration decision to join the ITER negotiations, many elements of the fusion program that are broadly applicable to burning plasmas will now be directed more specifically toward the needs of ITER, while some longer range technology development activities will be curtailed. The majority of existing and proposed program elements, however, already contribute to tokamak science, thereby providing a strong base for our future contributions to and ability to benefit from ITER.

Four areas characterize the FES program activities for fiscal year 2004 and beyond. These are Burning Plasmas, which will include our efforts in support of ITER; Fundamental Understanding, which includes theory, modeling, and general plasma science; Configuration Optimization, which includes experiments on advanced tokamaks, advanced magnetic configurations, and inertial fusion concepts, as well as facility operations and enabling R&D; and Materials and Technology, which includes fusion specific materials research and fusion nuclear technology research. Integrated progress in all of these thrust areas is required for ultimate success in achieving a practical fusion energy source.

The fiscal year 2004 budget supports a balanced fusion science program. The fiscal year 2004 budget request supports research in alternate confinement concepts, to include the final design and initial fabrication of the National Compact Stellarator Experiment facility at Princeton Plasma Physics Laboratory, facility upgrades and an increase in facility operations, research in inertial fusion energy and basic plasma science, as well as a focus on the use of high-end computational simulation.

HIGH ENERGY PHYSICS

Fiscal Year 2002 Appropriation—$697.4M; Fiscal Year 2003 Request—$725.0M; Fiscal Year 2004 Request—$738.0M

The High Energy Physics (HEP) program provides over 90 percent of the Federal support for the Nation's high energy physics research. This research seeks to understand the nature of matter and energy at the most fundamental level, as well as the basic forces that govern all processes in nature. High energy physics research

requires accelerators and detectors utilizing state-of-the-art technologies in many areas including fast electronics, high speed computing, superconducting magnets, and high power radio-frequency devices. Until 2007, when Europe's Large Hadron Collider (LHC) is scheduled to begin operations, the United States is the primary world center for HEP research. In fiscal year 2004, the HEP program will concentrate on facility utilization, including direct support for researchers, as well as incremental facility upgrades.

In fiscal year 2004, the Fermilab Tevatron Collider Run II will be in full swing. The Run II program will enable many advances and discoveries at the energy frontier, including: possible discovery of the long-sought Higgs particle, thought to be the key to understanding why particles have mass; providing even greater information about the heaviest known particle, the top quark, discovered at Fermilab in 1995; possible discovery of an entirely new class of particles that have been predicted, by many theories, to be present in Run II data; or unfolding of the as yet undiscovered space-time dimensions that have been postulated to complete the unification of fundamental interactions. A series of planned upgrades to the Tevatron accelerator complex, the major detectors, and computing facilities will continue in fiscal year 2004 in order to enable a vigorous physics program that will maintain Fermilab's scientific leadership through the end of the decade. The NuMI/MINOS project, scheduled for completion in September 2005, will provide a world-class facility to study neutrino properties and make definitive measurements of neutrino mass differences.

Building on the outstanding performance of the B-factory at the Stanford Linear Accelerator Center (SLAC), the HEP program will increase support for operation of the B-factory in fiscal year 2004 to break new ground in exploring the source and nature of matter-antimatter asymmetry in the B-meson system. The upcoming round of experimental results may provide evidence for new physics beyond the Standard Model of particle physics. Incremental upgrades are also planned in fiscal year 2004 for the accelerator to improve physics output and for the computing capabilities to cope with high data volumes.

Continued U.S. participation in the LHC project at CERN is a high priority in fiscal year 2004. The U.S. contributions to the LHC accelerator and the ATLAS and CMS detectors are on schedule and within budget for the scheduled start-up date of 2007. Focus of this effort will begin to shift in fiscal year 2004 from construction to pre-operations for the U.S.-built detector components and to developing the software and computing infrastructure necessary to exploit LHC physics.

Non-accelerator experimentation is a growing part of HEP research and offers many exciting opportunities for the future. Progress continues on particle astrophysics experiments and R&D in partnership with NASA. Collaborations on the Alpha Magnetic Spectrometer (AMS) and the Large Area Telescope (LAT), part of the Gamma-Ray Large Area Space Telescope (GLAST) mission, will be engaged in full detector fabrication and assembly in fiscal year 2004. The SuperNova Acceleration Probe (SNAP) will begin fabrication of detector prototypes in support of a 2006 Conceptual Design. These experiments are working toward solving key mysteries in astrophysics and cosmology, including dark energy, high energy gamma ray sources, and antimatter in space, all of which play a role in the story of the origin and fate of the Universe. Other non-accelerator experiments are located at ground level, such as the Pierre Auger project and the Supernova Cosmology Project, or deep under ground, such as neutrino detectors.

In addition, the program continues to support advanced technology R&D in fiscal year 2004 geared toward future accelerators, including a high-energy, high-luminosity Linear Collider. In January 2002, the HEPAP Subpanel on Long Range Planning stated that such a collider should be the highest priority of the U.S. HEP program.

NUCLEAR PHYSICS

Fiscal Year 2002 Appropriation—$350.6M; Fiscal Year 2003 Request—$382.4M; Fiscal Year 2004 Request—$389.4M

The Nuclear Physics (NP) program supports fundamental nuclear physics research, providing about 90 percent of Federal support for this field. NP research advances our knowledge of the properties and interactions of atomic nuclei and nuclear matter in terms of the fundamental forces and particles of nature. It also supports the scientific knowledge-base, technologies and trained manpower that are needed to underpin DOE's missions for nuclear-related national security, energy, and the environment.

The NP program seeks answers to questions in three broad areas. (1) The basic constituents of nuclei, the neutrons and protons (nucleons) are themselves each com-

posed of three quarks and the gluons that "carry" the strong force between them. Yet, these quarks are "confined" and cannot be found individually in nature. Understanding this confinement and the transition from a nucleon to quark description of nuclear structure is a central question of the field. (2) The early universe, up to a millionth of a second after the "Big Bang," is believed to have been a soup of quarks and gluons, a quark-gluon plasma. Creation of microcosms of this primordial matter in the laboratory is now being attempted in order to answer how the universe evolved at the very beginning of time. (3) The chemical elements are believed to have been created in stars and supernovae explosions, yet the nuclear reactions involved in this process involve nuclei far from the naturally occurring ones on earth. To answer how the elements were made (nucleosynthesis) requires producing exotic radioactive nuclear beams. Understanding the dynamics of supernovae also requires understanding the properties of the elusive neutrino which can only be detected in massive detectors.

In fiscal year 2004, the NP program will focus on enhancing the operations of the program's user facilities, especially the Relativistic Heavy Ion Collider (RHIC), so as to bring all operating facilities to about 83 percent of optimal utilization. This will increase beam hours for research by about 5 percent over the fiscal year 2003 Request. Nuclear Theory, new Low Energy instruments, and increased support to non-accelerator research such as neutrino experiments are also strongly supported.

In addition to increased operations at RHIC, fiscal year 2004 funding will support an aggressive experimental program with the newly completed G0 detector at Thomas Jefferson National Accelerator Facility (TJNAF) to begin to map out the strange quark contribution to the structure of the nucleon. The MIT/Bates research program with the BLAST detector is being initiated in fiscal year 2003 with completion planned in fiscal year 2004. The two Low Energy user facilities (ATLAS and HRIBF) will also increase running schedules in fiscal year 2004 for nuclear structure and astrophysics studies.

In fiscal year 2003–2005, the Sudbury Neutrino Observatory (SNO) will make sensitive measurements of the flux and spectra of solar neutrinos. Neutrino oscillations are evidence that neutrinos have mass, an observation that forces a re-evaluation of the existing Standard Model of particle physics.

SCIENCE LABORATORIES INFRASTRUCTURE

Fiscal Year 2002 Appropriation—$37.1M; Fiscal Year 2003 Request—$42.7M; Fiscal Year 2004 Request—$43.6M

The Science Laboratories Infrastructure (SLI) program plays a vital role in enabling the continued performance of world-class research at the Office of Science laboratories by funding line item construction projects to maintain the general purpose infrastructure (GPI) and the clean-up and removal of excess facilities. In fiscal year 2004, SLI will support six ongoing projects and one new start—seismic safety and operational reliability improvements at SLAC. Excess Facilities Disposition (EFD) will continue disposition of both contaminated and non-contaminated excess facilities, resulting in reduction of costs and risks while freeing-up valuable land. The fiscal year 2004 Budget Request also includes funding for the Oak Ridge Landlord subprogram.

SAFEGUARDS AND SECURITY

Fiscal Year 2002 Appropriation—$45.7M; Fiscal Year 2003 Request—$43.7M; Fiscal Year 2004 Request—$43.7M

Safeguards and Security reflects the Office of Science's commitment to maintain adequate protection of cutting edge scientific resources. In fiscal year 2004, Safeguards and Security will enable the Office of Science laboratories to meet the requirements of maintaining approved Security Condition 3 level mandates for the protection of assets. Integration of security into the laboratories' systems and continued risk management are also supported. In addition, critical cyber security tools and software will be purchased to respond to the ever changing cyber threat.

WORKFORCE DEVELOPMENT

Fiscal Year 2002 Appropriation—$4.5M; Fiscal Year 2003 Request—$5.5M; Fiscal Year 2004 Request—$6.5M

Workforce Development for Teachers and Scientists supports three subprograms: Pre-College Activities such as the National Science Bowl; the Undergraduate Research Internships for undergraduate students wishing to enter science, technology and science teaching careers; and Graduate/Faculty Fellowships for K–16 teachers of science, technology, engineering, and mathematics (STEM). Each of the subpro-

grams targets a different group of students and teachers in order to attract a broad range of participants to the programs and expand the Nation's supply of well-trained scientists and engineers. Focus of this program is on the Physical Sciences and other areas of research which underpin the DOE missions and have, over the last decade, seen a marked decline in the numbers of undergraduate degrees awarded. Initiated in fiscal year 2004 is the Laboratory Science Teacher Professional Development program that will provide long-term scientific community support from our National Laboratories for K–14 STEM teachers.

SCIENCE PROGRAM DIRECTION

Fiscal Year 2002 Appropriation—$149.5M; Fiscal Year 2003 Request—$137.3M; Fiscal Year 2004 Request—$150.8M

Science Program Direction enables a skilled, highly motivated Federal workforce to manage SC's research portfolio, programs, projects, and facilities in support of new and improved energy, environmental, and health technologies, and to provide continuous learning opportunities. Science Program Direction consists of four subprograms: Program Direction, Field Operations, Technical Information Management (TIM) and Energy Research Analyses (ERA).

The Program Direction subprogram supports Federal staff in Headquarters responsible for directing, administering, and supporting the broad spectrum of scientific disciplines. The Field Operations subprogram is the funding source for the Federal workforce in the Field complex responsible for providing business, administrative, and specialized technical support to DOE programs. The TIM subprogram collects, preserves, and disseminates the scientific and technical information of the DOE. The ERA subprogram provides the capabilities needed to evaluate and communicate the scientific excellence, relevance, and performance of Office of Science basic research programs.

As part of a restructuring effort, the Office of Science will focus on its Federal human capital in fiscal year 2004 to effectively respond to the science needs of the future and to the challenge of an anticipated 50 percent turnover of retirement-eligible senior scientists over the next 5 years. Also in fiscal year 2004, the Office of Science continues to support a corporate DOE information management system, the Electronic R&D Portfolio Management Tracking and Reporting Environment (ePME), which enables end-to-end tracking of research projects, information sharing across programs, and snapshots of the Department's R&D portfolio. ePME will integrate with the e-Grants functions of e-Government, the Department's e-Financial Management System, and the e-Procurement Modernization System.

CONCLUSION

The Office of Science occupies a unique and critical role within the U.S. scientific enterprise. We fund research projects in key areas of science that our Nation depends upon. We construct and operate major scientific user facilities that scientists from virtually every discipline are using on a daily basis, and we manage civilian national laboratories that are home to some of the best scientific minds in the world.

Our researchers are working on many of the most daunting scientific challenges of the 21st Century, including pushing the frontiers of the physical sciences through nanotechnology, exploring the key questions at the intersection of physics and astronomy, and opportunities at the intersection of the physical science, the life sciences and scientific computation to understand how the instructions embedded in genomes control the development of organisms, with the goal of harnessing the capabilities of microbes and microbial communities to help us to produce energy, clean up waste, and sequester carbon from the atmosphere. The Office of Science is also pushing the state-of-the-art in scientific computation, accelerator R&D, plasma confinement options and a wide array of other technologies that advance research capabilities and strengthen our ability to respond to the rapidly changing challenges ahead.

I want to thank you, Mr. Chairman, for providing this opportunity to discuss the Office of Science's research programs and our contributions to the Nation's scientific enterprise. On behalf of DOE, I am pleased to present this fiscal year 2004 budget request for the Office of Science.

This concludes my testimony. I would be pleased to answer any questions you might have.

Senator DOMENICI. With that, we will proceed now to you, David. Mr. Garman, nice to have you here. How do you like your work?

OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

STATEMENT OF DAVID K. GARMAN, DIRECTOR

Mr. GARMAN. Oh, I like it a great deal, Mr. Chairman, and thank you. And thank you, Senator Craig, for your kind words. I appreciate this opportunity, and I appreciate the support of the subcommittee for our work.

As you know, funding for activities in my office is split between the Energy and Water Development and the Interior Appropriations bills. Our overall budget request for fiscal year 2004 is $1.32 billion, a bit more than our request for fiscal year 2003. However, our fiscal year 2004 request for activities in the Energy and Water Development Appropriations is $37.2 million over the amount we requested for fiscal year 2003.

As the Chairman noted, our most notable expansion is in the area of hydrogen and fuel cell vehicles research and development, resulting from the President's Hydrogen Fuel Initiative announced during his State of the Union Address. I will say just a few words about hydrogen before highlighting other elements of our proposal.

Our hydrogen technology subprogram is a key component of the President's Hydrogen Fuel Initiative. Our fiscal year 2004 request is $48.1 million above our fiscal year 2003 request. This does not include additional funds that have been requested for hydrogen in the Offices of Fossil and Nuclear Energy. Our total hydrogen request is over $100 million. These funds would be used to establish a national research effort on hydrogen storage, to enhance technology development for hydrogen production from renewables and distributed natural gas, to accelerate work on codes and standards development, to accelerate work on hydrogen education, and to validate some hydrogen infrastructure technologies to support fuel cell vehicles and their test and evaluation.

The increase in funding is designed to enable the industry to make a commercialization decision on hydrogen fuel cell vehicles and infrastructure by 2015. We believe this can help bring affordable hydrogen fuel cell vehicles to the showroom floor by 2020.

For our solar energy technology program we are seeking $79.7 million, essentially the same as our fiscal year 2003 request. We want to continue our work to bring down the cost and improve the reliability of solar photovoltaic systems.

Our wind energy technology program has been successful in bringing down the cost of electricity generated from wind. Wind energy systems have been the fastest growing source of electricity worldwide for over a decade and are now providing cost-competitive power in high wind speed areas. As a result, our focus for wind R&D has shifted to larger blades and turbines using advanced materials that will allow economically viable development in the lower wind speed areas that are present more evenly across the Nation.

In fiscal year 2004, we are requesting $41.6 million for wind energy, which is $2.4 million less than our fiscal year 2003 budget request. This request is in alignment with our projected needs to achieve our goals.

For our hydropower technology work, we are requesting about $7.5 million, the same level of funding we requested last year. As Senator Craig pointed out, our work in this area focuses on improv-

ing the environmental performance of hydropower plants by developing turbines that reduce fish injury and improve downstream water quality.

Geothermal energy offers promise as a base load renewable energy resource, particularly in the Western United States. Our program focuses on exploration and reservoir technologies and drilling research to enable industry to locate and produce new geothermal fields at greatly reduced cost. In fiscal year 2004, we are requesting $25.5 million for these activities, $1 million less than our fiscal year 2003 request.

Biomass and biorefinery systems present some interesting challenges and opportunities for us. We know how to make power, as well as a variety of individual fuels, chemicals, and products from biomass. But we do not know necessarily how to do it affordably and competitively. We believe that the synergies of an integrated biorefinery that makes both power, products, and fuels cannot only help us reduce our dependence on imported oil, but expand economic opportunities in rural areas of the country.

For the first time, we have brought together a diverse industry together and produced a vision, an R&D road map, that is helping us to restructure our biomass program and to focus on the most promising long-term opportunities for these technologies.

We have also dramatically improved the collaboration between the Department of Energy and the U.S. Department of Agriculture. In that connection, the farm bill has provided $14 million in mandatory biomass funding, which we are going to jointly manage with the Department of Agriculture under the direction of the Biomass Research and Development Board established under the Biomass R&D Act of 2000.

In fiscal year 2004, we are also requesting almost $77 million for electricity reliability, slightly more than our fiscal year 2003 request. That program consists of four main areas, including high temperature superconductivity, transmission reliability research, distribution and interconnection energy storage research, and the renewable energy production incentive.

We are creating a new program office in the Department bringing various transmission-related activities together. We look forward to presenting more information to you about that in the weeks ahead.

PREPARED STATEMENT

For now I ask that my full statement appear in the record. I am happy to answer any questions the committee may have, either now or in the future.

Senator DOMENICI. It will be made a part of the record. Thank you very much.

[The statement follows:]

PREPARED STATEMENT OF DAVID K. GARMAN

Mr. Chairman, Members of the Subcommittee, I appreciate the opportunity to testify before you today on the fiscal year 2004 budget request for the Office of Energy Efficiency and Renewable Energy (EERE).

As you know, the EERE budget is split between Energy and Water Development and Interior Appropriations Bills. Our overall budget request for fiscal year 2004 is $1,320,000,000 compared to $1,318,651,000 requested in fiscal year 2003. Our fis-

cal year 2004 request for our Energy and Water Development programs totals $444,207,000, or 34 percent of EERE's budget, compared to $407,000,000 requested in fiscal year 2003. The most notable programmatic expansions are in the area of hydrogen and fuel cell vehicles research and development (R&D), reflecting the priorities and recommendations of the President's National Energy Policy, the Department of Energy's (DOE) mission, EERE's Strategic Plan, and the EERE's Strategic Program Review.

This request reflects EERE's streamlined new organization. Two years ago, EERE was divided into 31 programs, in 17 offices, stovepiped into 5 market sectors. Overlapping layers of management and duplicative and inconsistent business systems generated significant inefficiencies and made it difficult to ensure accountability and the most cost-effective application of taxpayer funds. Responding to the President's Management Agenda and our own Strategic Program Review, we launched a dramatic restructuring of the EERE program in June 2002. This restructuring streamlined our organization, eliminating up to four management levels, and centralizing administration functions into a single support organization with a focus on developing consistent, uniform, and efficient business practices. This is arguably the most dramatic restructuring in EERE's history.

—The restructuring combined all the hydrogen and fuel cell activities, formerly scattered across two market sectors and three programs, into a single program for greater efficiency and synergy.

—The restructuring combined all the bioenergy-related activities, formerly scattered across three market sectors and three programs, into a single program focused on advanced biorefineries. If successful, this research will allow waste plant matter to be turned into high value chemicals, fuels, and power.

—The fiscal year 2004 budget is fully aligned with EERE's new management structure and strategic goals, allowing a strong linkage between congressional appropriations and the performance and productivity of EERE's research and development (R&D) and deployment activities.

The fiscal year 2004 budget supports EERE's R&D and technology deployment efforts to provide Americans with increased energy security and independence through utilization of diverse domestic supplies, greater freedom of choice of technology, and reducing the financial costs and environmental impacts of energy utilization.

As Secretary Abraham noted recently, the Department has ". . . an ambitious, long-term vision of a zero-emissions future, free of reliance on imported energy." We must call upon science, technology, and the research talents in our national laboratories, universities, and industry to help us move beyond today's energy choices towards carbon-free generation of electricity and fuels, including hydrogen.

Secretary Abraham has also made clear that all missions at the Department flow from our core mission to support national security. This EERE fiscal year 2004 budget demonstrates that the Department takes its responsibility toward national security seriously as it does its responsibilities toward science and technology. The Department has taken a deliberate and integrated approach to its research and development portfolio, using the strengths of all DOE programs to address this central mission. Clearly, environmental security and economic security underpin national security and each is sustained by science.

What is more, there is only one way to build an integrated budget and that is to engage in a vigorous and disciplined planning process that forces programs to set priorities.

Our EERE fiscal year 2004 budget request has been developed with these challenges and opportunities in mind.

THE PRESIDENT'S HYDROGEN FUEL INITIATIVE

Mr. Chairman, the big news in our fiscal year 2004 budget is, of course, the President's Hydrogen Fuel Initiative, which directly supports EERE's number one priority to dramatically reduce or even end dependence on foreign oil.

Our nation currently imports 55 percent of our oil—a dependence that is projected to rise to 68 percent by 2025. Since two thirds of the 20 million barrels of oil we consume each day is used for transportation, we must focus on finding alternative, domestic fuels to power our transportation system if we ever expect to reverse this trend.

In his recent State-of-the-Union address, President Bush announced a groundbreaking plan to transform our nation's energy future from one dependent on foreign petroleum, to one that utilizes the most abundant element in the universe—hydrogen. The concept for this initiative is simple, yet profound—create automotive operating systems that run on hydrogen rather than gasoline. The benefits will be

considerable and widespread. Hydrogen can be produced from diverse domestic sources, freeing us from a reliance on foreign imports for the energy we use at home. Hydrogen can fuel ultra-clean internal combustion engines, which would reduce auto emissions by more than 99 percent. And when hydrogen is used to power fuel cell vehicles, it will do so with more than twice the efficiency of today's gasoline engines—and with none of the harmful emissions. In fact, fuel cells' only byproduct is pure water.

On February 6, 2003, at an event on energy independence in Washington, D.C., featuring new uses for fuel cells including automobiles, the President reiterated his commitment to his new Hydrogen Fuel Initiative stating, "The technology we have just seen is going to be seen on the roads of America. And it's important for our country to understand that by being bold and innovative, we can change the way we do business here in America; we can change our dependence upon foreign sources of energy; we can help with the quality of the air; we can make a fundamental difference for the future of our children."

During his speech on energy independence, the President also provided details of his initiative stating, "We must make hydrogen more plentiful and produce it in the most efficient, cost-effective way. That is one of our challenges . . . We must increase the capacity of hydrogen storage systems. And we must put in place the infrastructure to get hydrogen to the consumers. There would be nothing worse than developing a car and having no place for somebody to find the fuel. People aren't going to buy many cars if they can't refuel their car."

To support the President's vision we need to make the necessary research and development investments to develop vehicles powered by hydrogen fuel cells and the infrastructure to support them. The President's Initiative will accelerate research and development on hydrogen production, delivery, storage and distribution, and establish the necessary safety-related codes and technology standards. In addition, it will accelerate the demonstration of fuel cell vehicles and hydrogen infrastructure so that these technologies can be validated under real world conditions.

The government's role here is clear. We will coordinate and cost-share the high-risk R&D work of numerous private sector partners and our national network of science laboratories. Government coordination of this undertaking will also help resolve one of the difficulties associated with development of a commercially viable hydrogen fuel cell vehicle: the "chicken and egg" question. Which comes first, the fuel cell vehicle or the hydrogen production and delivery-refueling infrastructure to support it? The President's Initiative, in conjunction with FreedomCAR—the public-private partnership with U.S. automakers launched last year to accelerate the development of practical, affordable hydrogen fuel cell vehicles—answers the question by proposing to develop both systems in parallel. By so doing, federal investments will help to advance commercialization of hydrogen fuel cell vehicles and infrastructure by 15 years, from approximately 2030 to 2015.

To meet this challenge, the President's fiscal year 2004 budget request commits $1.7 billion over five years for the FreedomCAR partnership and Hydrogen Fuel Initiative. This includes $1.2 billion for hydrogen and fuel cells—$720 million in "new" money (i.e., not included in baseline projections of spending). EERE's overall fiscal year 2004 budget request for the FreedomCAR partnership and Hydrogen Fuel Initiative is $256.6 million. There is an additional $15.5 million for hydrogen production research requested by the Offices of Fossil and Nuclear Energy, and $0.7 million requested by DOT Research Special Projects Agency.

Mr. Chairman, we stand on the cusp of revolutionary change in personal transportation in this country—and the world. The President has completely recast this Nation's vision of personal transportation by describing a future where vehicles will be fueled by hydrogen—and he is taking the steps necessary to lead us to that future.

FISCAL YEAR 2004 ENERGY AND WATER DEVELOPMENT BUDGET REQUEST

For fiscal year 2004, we request a $37,207,000 increase above our fiscal year 2003 amended budget request.

Let me now briefly review the portfolio of Renewable Energy Resources programs within the Office of Energy Efficiency and Renewable Energy. Before I begin, I'd like to highlight how the President's Management Agenda has helped us focus our resources and become better stewards of the taxpayers' dollars. For example, the R&D investment criteria help us guide budget decisions to ensure we fund only activities that can provide real public benefits and that the private sector would not undertake without our help. And the budget-performance integration initiative, through the Program Assessment Rating Tool (PART), has helped us to focus on continuing to improve our performance goals, and to identify program planning and management strengths and challenges.

Two years ago, the President's Management Agenda pointed out that Federal government R&D programs in general "do not link information about performance to our decisions about funding. Without this information, decisions about programs tend to be made on the basis of anecdotes, last year's funding level, and the political clout of local interest groups." This year, our funding request is in better alignment with what it will take to achieve our goals.

Hydrogen Technology

The Hydrogen Technology Subprogram is a key component of the President's Hydrogen Fuel Initiative.

The program works with industry to improve efficiency and lower the cost of technologies that produce hydrogen from renewable energy resources and natural gas. In addition, the program works with the national laboratories to reduce the cost of technologies that produce hydrogen directly from sunlight and water. Hydrogen can be used in stationary applications for residential, commercial and industrial fuel cells, as well as in fuel-cell powered vehicles. Development of this clean energy carrier will lessen our dependence on imported fuels in both stationary and transportation applications.

In fiscal year 2004, we request $87,982,000 ($48,101,000 more than our fiscal year 2003 budget request) for the Hydrogen Technology Subprogram (there is an additional $15.5 million in the Offices of Fossil and Nuclear Energy for a total of $103.5 million). This will be used to establish a national research effort on hydrogen storage; to enhance technology development for hydrogen production from renewables and distributed natural gas; to accelerate codes and standards development; to create a major hydrogen education effort; and to validate hydrogen infrastructure technologies to support fuel cell vehicle test and evaluation.

Our fiscal year 2004 budget request represents a significant consolidation and realignment in the Hydrogen, Fuel Cells, and Infrastructure Technologies Program when compared to the fiscal year 2003 budget request. This budget request reflects the functional priorities of the program: hydrogen production and delivery, hydrogen storage, hydrogen infrastructure validation, safety and codes/standards related to hydrogen and its infrastructure, and education and crosscutting analysis. The new budget structure consolidates all electrolyzer research and development under production and delivery.

In addition, the fiscal year 2004 request proposes that all fuel cell activities be performed under Interior and Related Agencies Appropriation. This is a change since some fuel cell work was requested under Energy and Water Development Appropriation in fiscal year 2003. Also, all hydrogen production, delivery, and storage work is proposed to be under the Energy and Water Development Appropriation request in fiscal year 2004. This is a change since some hydrogen storage and offboard natural gas reforming work was requested under Interior and Related Agencies in fiscal year 2003.

The increase in funding for fiscal year 2004 compared to the fiscal year 2003 request enables hydrogen production, storage, and infrastructure technology goals to be accelerated 15 years to enable industry to make a commercialization decision regarding hydrogen infrastructure and fuel cell vehicles by 2015.

Specific fiscal year 2004 program activities include:

—Accelerating development of low-cost, small-scale reformers and separation technology to enable hydrogen generated from distributed natural gas to achieve $3.00 per gasoline gallon equivalent by 2005 and to be competitive with gasoline by 2010 ($1.50 per gasoline gallon equivalent, delivered, pre-tax).

—Accelerating and expanding research on the production of hydrogen from renewable resources to reach a 2008 goal of $2.55 per gasoline gallon equivalent at the plant gate.

—Creating a national research effort in hydrogen storage technologies, based on low pressure, solid state materials, to enable achievement of 2010 goals of 2.0 kWh/kg (6 percent by weight hydrogen storage capacity), 1.5 kWh/l and $4/kWh.

—Conducting operations of the Las Vegas fueling station to determine emissions and system efficiency. Initiating limited "learning" demonstrations of hydrogen refueling stations to support fuel cell vehicle test and evaluation.

—Providing leadership in developing safety-related codes and standards and conducting necessary coordination with the international community so that U.S.-based technology can compete globally.

These efforts support the Hydrogen Fuel Initiative, and will enable the development of hydrogen fuel cell vehicles for the showroom floor by 2020. Success of these programs will begin to eliminate the need for imported oil, while simultaneously beginning to eliminate emissions and significantly reducing greenhouse gases from

America's transportation fleet without affecting the freedom of personal mobility we demand.

Solar Energy Technology

The EERE Solar Energy Technology Program develops solar energy systems that are more efficient, reliable, and affordable for converting sunlight into electricity, space heat, hot water, and lighting. A primary objective of the program is to increase the value of solar energy by putting it at the point of use, making it an integral part of super efficient, state-of-the-art residential and commercial buildings and industrial establishments.

In fiscal year 2004, we request $79.7 million for the Solar Energy Technology Program, which is level funding with our fiscal year 2003 request. The fiscal year 2004 activities are as follows:

Under Photovoltaic (PV) Energy Systems, we will increase technology development to support module and systems reliability improvements. In thin film modules, we will increase funding for accelerated lifetime testing and diagnostics to determine failure modes in pre-commercial products. In systems, we will increase funding for the inverter initiative to accelerate attainment of a next-generation grid-tied inverter with a greater than twenty-year lifetime. We will begin the second year of three-year contracts under the PV Science Initiative with universities to develop next-generation PV materials and devices that have the potential for dramatic cost reductions. The PV Science Initiative will more fully develop new ideas and concepts that can replace conventional technologies with a new generation of lower-cost, easier-to-manufacture technologies. In the Thin Film Partnership, the program will continue funding the most promising industry cost-shared contracts on technologies making the greatest achievements.

In Solar Building Technology Research, we will continue development of a polymer water heater capable of operation in cold climates and test a hybrid solar daylighting system.

The Concentrating Solar Power subprogram will be phased-out in accordance with the National Academy of Science recommendations.

Zero Energy Buildings

The focus of the Zero Energy Buildings concept involves efforts to integrate renewable energy systems into building designs and operations, such as integrating photovoltaic, water heating systems and/or space conditioning systems. These buildings use renewable energy sources so that the buildings produce as much energy as they consume on an annual basis.

In fiscal year 2004, we request $4.0 million for the Zero Energy Buildings program, $4.0 million less than our fiscal year 2003 budget request. The program will evaluate its activities to ensure no duplications or overlaps with Interior-funded efforts in the Building Technologies Program.

As part of the reorganization of EERE in fiscal year 2002, Zero Energy Buildings activities have been moved from the Solar Energy Program to the Buildings Technologies Program. This shift will enable more effective access to the residential and commercial building industries for Zero Energy Buildings technology developers and expand the range of opportunities for industry participation and cost sharing. The Zero Energy Buildings activities will continue to maintain effective technical coordination with the Solar Energy Program.

In fiscal year 2004, we will focus on completing the evaluation and monitoring of first generation Zero Energy Buildings homes, built by leading homebuilders, to verify a 50 percent reduction in annual utility bills to $600 per year for an average sized home in a temperate climate.

Wind Energy

Wind energy systems have been the fastest growing source of electricity worldwide for over a decade, and are now providing cost-competitive power in high wind speed areas. As a result, the Department's focus for wind energy R&D has shifted to advanced technologies to allow economically viable development in the nation's more widespread lower wind speed areas. These areas are on average five times closer to major load centers, providing an opportunity to relieve transmission constraints as a major wind energy barrier, and over twenty times more abundant than currently-economic high wind areas. Under the Technology Viability key activity, the program is underway with a broad range of cost-shared public/private partnerships coupled with laboratory supporting research and testing to achieve low wind speed development goals for both large turbines used for utility scale wind farms, and for smaller (<100 kilowatt) turbines for use in distributed power applications. The Technology Application key activity targets remaining technical and institutional barriers to wind energy use, including grid systems integration, resource as-

sessment, outreach to states and stakeholders, and support for near-term industry needs such as certification testing.

In fiscal year 2004, we request $41,600,000 for the Wind Energy subprogram, $2.4 million less than our fiscal year 2003 budget request. The request is in alignment with our projected needs to achieve our goals.

In fiscal year 2004, the Wind Energy subprogram will select and commence several new industry partnership projects for concept studies, component development, and/or full system development under competitive solicitations issued in 2003 for both large wind turbines and small, distributed power scale turbines. It will also conduct research efforts in wind turbine aerodynamics, structures, materials, advanced components, and wind characteristics to support development of new and improved tools and technology for low wind speed system design and applications. Advanced systems integration studies will assess opportunities for coordinated operation of wind and hydropower generation, and production of hydrogen from wind and hydropower.

Hydropower

In the case of hydropower, the program focuses on improving the environmental performance of hydropower plants by developing turbines that reduce fish injury and improve downstream water quality. The Department has engaged the expertise of the national laboratories to study and better understand hydropower's biological and environmental effects. Study results have been critical to the development of design thresholds for industry to use in their efforts to improve existing turbine designs.

In fiscal year 2004, we request $7,489,000 for the hydropower subprogram, the same level of funding as our fiscal year 2003 request.

Under Technology Viability: Advanced Hydro Turbine Technology, we have increased funding in fiscal year 2004 by $500,000 to support testing of new prototype hydro turbines.

Under Technology Application: Low-Head/Low-Power R&D, we have decreased funding in fiscal year 2004 by $500,000, to reflect a shift in funding to higher-priority testing of new prototype hydro turbines under Technology Viability.

In fiscal year 2004, the hydropower subprogram will develop and test full-scale (greater than 1 MW) prototypes of retrofit and new environmentally friendly turbine designs under competitively selected public private partnerships awarded in prior years. The Department will also complete the low head/low power resource assessment of all 50 states, identifying the undeveloped hydropower resources that could be developed without building new impoundments.

Geothermal Technology

The Geothermal Technology Development Program works in partnership with U.S. industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply, capable of meeting a portion of the Nation's heat and power needs, especially in the West. The program focuses on exploration and reservoir technologies, and drilling research because better understanding of geothermal resources and cost-effective means of accessing those resources will enable industry to locate and produce new geothermal fields at greatly reduced cost.

In fiscal year 2004, we request $25,500,000 for geothermal program activities, $1 million less than our fiscal year 2003 budget request.

In fiscal year 2004, the program will step up work on Enhanced Geothermal Systems (EGS) cost-shared projects at three competitively-selected sites. In fiscal year 2004, we will increase funding for EGS by $2.5 million over our fiscal year 2003 budget request due to the high priority of this program area and budget projections supporting the field development phases of the cost-shared projects. The program will also support at least five cost-shared, competitively-selected, exploration projects initiated with industry to validate new technology and find and confirm new geothermal resources within the United States.

Biomass and Biorefinery Systems R&D

In fiscal year 2004, we are requesting $69,750,000 for Biomass/Biorefinery Systems, a $16,255,000 decrease from our fiscal year 2003 budget request.

For the first time we have brought a diverse industry together and produced a vision and R&D roadmap that has increased the level of industry investment. This roadmap has allowed us to begin the process of rebuilding the program and focusing on the most promising long-term opportunities for these technologies. We have dramatically improved the collaboration among federal agencies, especially the Department of Agriculture (USDA). In addition, the Farm Bill provided direction and funding to USDA to work with DOE in advancing biomass technologies. In fact, the Farm Bill provides $14 million in fiscal year 2004 mandatory biomass funding for

the Department of Agriculture, which DOE's Biomass Program will jointly manage at the direction of the Biomass Research and Development Board established under the Biomass R&D Act of 2000.

The Department has focused its R&D efforts to high-priority, long-term technologies, both within the Biomass Program and the entire EERE portfolio. Earlier last year, the EERE bioenergy activities were integrated into one office to help focus resources on a limited and more coherent set of goals and objectives, increasing collaboration with industry, reducing overhead expenses, and exploiting synergies among similar activities in support of a future biorefinery industry. This focus on a clear set of goals, substantial leveraging of research funding with industry, and the transfer to industry of a number of demonstration activities that industry should continue to pursue without federal support has allowed a reduction in the need for funding to achieve our goals.

Our fiscal year 2004 activities will include additional long-term, high-risk R&D in thermochemical conversion in support of biorefinery development. Efforts will continue on the testing of clean up and conditioning technologies and catalysts needed for biomass gasifiers. An industrial partner will validate the performance of an organism capable of fermenting multiple biomass sugars for ethanol production.

Intergovernmental Activities

Intergovernmental Activities support the program mission by providing consumers with improved choices for efficient and renewable energy products. Intergovernmental Activities are managed as part of the Weatherization and Intergovernmental Program, which is comprised of grant-related and technical assistance activities brought together through the reorganization of Energy Efficiency and Renewable Energy (EERE) in fiscal year 2002. Combining these activities will improve the Department of Energy's effectiveness in deployment of efficient and renewable energy technologies by streamlining administration of program funding and consolidating management of competitive awards. The former Renewable Implementation and Support activities have been given stronger focus by inclusion in the Weatherization and Intergovernmental Program.

The Intergovernmental Activities subprogram receives appropriations from both the Energy and Water Development and the Interior and Related Agencies subcommittees. Interior activities focus on energy efficiency measures, while Energy and Water Development activities focus on maintaining working relationships with international and Native American tribal governments that inform and assist consumers with renewable and efficient energy options.

In fiscal year 2004, we request $12,500,000 for Intergovernmental Activities, $2.307 million less than our fiscal year 2003 budget request.

—The International Renewable Energy Program promotes clean U.S. exports, expanding the market of U.S. industries and reducing the cost of energy to our trading customers while improving their environment, reducing air and water pollution and greenhouse gas emissions, and creating new jobs. In fiscal year 2004, we request $6.5 million for international activities (the same level of funding as our fiscal year 2003 request).

—The Tribal Resources Program provides assistance to Native American Tribes and Tribal entities in assessing energy resources, comprehensive energy plan development, energy technology training, and project development. In fiscal year 2004, we request $6.0 million to assist Tribes in ways to use renewable energy technologies on Tribal lands. Funds will be awarded competitively.

The U.S. Country Studies Program has completed its mission of showing how the United States could cost-effectively reduce global greenhouse gas emissions through energy efficiency and renewable energy exports and cooperative agreements with other countries. The funding has been shifted to support Administration initiatives such as the Energy Efficiency for Sustainable Development and the Global Village Energy Partnership Initiatives announced at the World Summit for Sustainable Development. DOE expects to leverage these investments with loans and private investments. The goal is to attain significant energy savings and environmental and quality-of-life improvements for the host countries and their governments and citizens.

Electricity Reliability

Electricity Reliability provides funds for our Distributed Energy and Electricity Reliability Program. This Program leads a national effort to develop a flexible, smart, and secure energy system through advanced technologies that improve capacity utilization of the transmission and distribution system and through tools that provide real-time information to system operators. This Program offers solutions

that bridge both the supply- and demand-side of the energy equation and the need to upgrade our electric energy infrastructure.

The National Energy Policy and the follow-up National Transmission Grid Study (NTGS) published in May 2002 identified critical needs to modernize the nation's electric delivery system. This budget initiates key responses to the 51 recommendations of the Grid Study including bottleneck assessment, interaction with FERC on standard market design and critical research and development needs. The fiscal year 2004 program consists of four main areas: High Temperature Superconductivity (HTS), Transmission Reliability Research, Distribution and Interconnection, Energy Storage Research, and Renewable Energy Production Incentive.

In fiscal year 2004, we request $76,866,000 for Electricity Reliability, $360,000 more than our fiscal year 2003 budget request.

For the HTS program, we request $47.838 million in fiscal year 2004 to develop applications of superconducting materials for the electricity delivery system. High temperature superconducting materials can be used to make wire conductors that are capable of carrying more current than existing conductors while having virtually no electric line losses of energy. The lack of electrical resistance of HTS materials makes it possible to have super-efficient generators, transformers, and transmission and distribution cables that reduce energy losses by half while using equipment that is about one-half the size of present electrical systems.

Transmission system operations have been made more complex by the growing volume of wholesale power transactions. As a result, data collection and visualization tools for utility planners and system operators are required that boost diagnosis and response times and increase the efficiency of market operations. The Transmission Reliability activity has developed and installed prototype voltage and frequency monitoring and visualization tools that allow transmission operators to immediately recognize and correct system problems. Other reliability tools are being installed, such as prototype satellite-synchronized devices that afford operators a real-time view of system conditions, provide information for reliable operation of the grid, and enable more efficient operation of competitive electricity markets. In fiscal year 2004, we request $10.720 million to expand R&D on grid monitoring, data collection, and visualization tools.

The Transmission Reliability R&D subprogram request is proposing a new initiative in fiscal year 2004—the National Transmission Infrastructure (NTI) Initiative, with requested funding of $3.0 million. This initiative responds to the NTGS. The NTI Initiative addresses the technical and market-related recommendations in the NTGS that call specifically for DOE actions. Actions include "national-interest" transmission lines assessment, and advanced technologies for relief of transmission congestion, including sensors, monitoring and control for real time operation, advanced conductors, analysis of new system configurations and dynamics, and demand response. In addition, increased emphasis will be placed on field validation and testing and on providing more technical assistance to states and regions on topics such as regional resource and transmission planning.

Interconnection, communications, and control systems are needed to allow for a more "plug & play" design that can revolutionize energy markets and create new products and services for industrial, commercial, and governmental consumers who are interested in hassle-free distributed energy solutions. The Distribution and Interconnection (formerly DER Electric Systems Integration) activity is developing standards, conducting tests, and performing analysis for the interconnection and integration of distributed energy technologies for customers and electric distribution systems. It includes activities to develop the microgrid concept, to analyze the impact of high levels of penetration of distributed energy devices on the distribution system, and to address technical, institutional, and regulatory barriers to the expanded use of distributed energy resources. In fiscal year 2004, we request $7.249 million for this Subprogram.

The Energy Storage Research activity addresses important challenges in the efficient operations of electric generation, transmission, and distribution systems. As a peak shaving tool during times of transmission overload, or during price peaks, energy storage allows more efficient allocation of energy resources without necessarily producing additional emissions. Energy storage systems can be used to provide back-up power and power quality support to consumers, potentially saving billions of dollars in downtime costs, damaged equipment, and disrupted operations. In fiscal year 2004, we request $5.0 million for Energy Storage Research activities to support higher priority Transmission Reliability research and development, and take advantage of potential synergies with expected developments under the Vehicle Battery Program, which significantly increased its funding request for fiscal year 2004.

The Renewable Energy Production Incentive Program stimulates electricity production from renewable sources owned by States or smaller private sector groups.

In fiscal year 2004, we request $4.0 million, the same funding level as our fiscal year 2003 budget request.

Departmental Energy Management Program (DEMP)

DEMP targets services at DOE facilities to improve energy and water efficiency, promote renewable energy use, and manage utility costs in facilities and operations. In fiscal year 2004, we request $2.3 million for DEMP activities, $700,000 less than our fiscal year 2003 budget request. DEMP will audit facilities to identify energy conservation opportunities; provide funding for best practices identification and dissemination; and accomplish energy conservation retrofits through direct funding and alternative financing.

National Climate Change Technology Initiative (NCCTI)

In response to the President's commitment of the United States to develop a sensible, science-based approach to the issue of climate change, facilitate progress toward achieving climate change goals, near-term and long-term, and implement the President's National Climate Change Technology Initiative, the Department has requested in fiscal year 2004 a total of $40 million for the NCCTI Competitive Solicitation program. Funding is requested in four R&D program accounts, as follows: Energy and Water Development: EERE (Energy Supply—$15 million) and NE (Energy Supply—$2.3 million); and Interior and Related Agencies: EERE (Energy Conservation—$9.5 million) and FE (Fossil Energy R&D—$13.2 million).

These funds will be used to support a NCCTI competitive solicitation aimed at exploring concepts, technologies and technical approaches that could, if successful, contribute in significant ways to: (a) future reductions in or avoidances of greenhouse gas emissions; (b) greenhouse gas capture and sequestration (permanent storage); (c) capture and conversion of greenhouse gases to beneficial use; or (d) enhanced monitoring and measurement of greenhouse gas emissions, inventories and fluxes in a variety of settings.

The NCCTI competitive solicitation is intended to spur innovation and accelerate technical progress on climate change technology development. The competitively selected research will complement DOE's existing portfolio of climate change-related R&D activities, and will be consistent with their missions, goals and objectives. The Climate Change Technology Program will manage the NCCTI competitive solicitation.

Facilities and Infrastructure

The Facilities and Infrastructure budget addresses capital investments at two DOE laboratory sites: the National Renewable Energy Laboratory (NREL), and Oak Ridge National Laboratory (ORNL).

NREL is the Nation's premier laboratory for renewable energy R&D. It also works to improve energy efficiency, advance related science and engineering, and facilities technology commercialization. In fiscal year 2004, we request $4.2 million for operating expenses.

For ORNL in fiscal year 2004, we request $750,000 to complete the design of a new multistory building of approximately 52,000 square feet to provide facilities for EERE R&D activities. This building will be a state-of-the-art facility designed to operate as a demonstration of energy efficiency technology. Energy Star certification will be sought for applicable portions of the building.

Fiscal year 2004 funding is requested to award the Architectural-Engineering contract for the project design and to provide project management. This budget provides half of the requested amount for Project Engineering and Design. Because industry will directly benefit from this facility, we are requiring 50 percent industry cost share for all phases of the project, including building design, as recommended in the National Transmission Grid Study. The project also is consistent with the ORNL Strategic Facilities Plan and complementary to the Facilities Revitalization Project of the DOE-ORNL Office of Science initiative to modernize their national laboratories.

Program Direction

Program Direction provides the federal staffing resources as well as associated properties, equipment, supplies and materials required for supporting the responsive management and oversight of programs. Program Direction also funds support service contractors, equipment, travel, and crosscutting activities.

In fiscal year 2004, we request $16.577 million, $390,000 more than our fiscal year 2003 budget request.

CONCLUSION

Mr. Chairman, Members of the Subcommittee, we welcome the challenge and the opportunity to play a vital role in this Nation's energy future and to support our national security.

This completes my prepared statement. I would be happy to answer any questions you may have.

Senator DOMENICI. Mr. Magwood, you are last, but not least. Congratulations on the nuclear work. And we finally got some good funding in some big areas this year. It took about 3 years, but we are there now. Proceed to give us a summary, and your statement will be made a part of the record.

OFFICE OF NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY

STATEMENT OF WILLIAM D. MAGWOOD, IV, DIRECTOR

Mr. MAGWOOD. Thank you, Mr. Chairman. This is an exciting year to be here before you speaking about the nuclear energy program. As you have observed, we have gone through a difficult time over the years. After many years of planning and many years of talking to our stakeholders in the research community, it is a pleasure to be here with a budget that really lays the groundwork for the future.

The programs proposed in our budget reflect the administration's commitment to nuclear energy and one that is interested in doing what is necessary to get new nuclear technologies deployed in the United States and around the world. The salient change in our fiscal year 2004 budget request from previous years is the fact that we are now in the process, as Senator Craig mentioned, of integrating the Idaho National Engineering and Environmental Laboratory as part of our nuclear family. We are in the process of planning for the future of this laboratory and working with other labs across the country. I expect INEEL to become the center for our overall efforts to develop advanced nuclear reactor and fuel treatment technologies.

ADVANCED FUEL CYCLE INITIATIVE

One of the activities at INEEL, in association with many other labs that we expect to see grow over the years, is our budget proposal for the Advanced Fuel Cycle Initiative (AFCI) that you mentioned earlier. With the $63 million proposed in fiscal year 2004, this is one of the Secretary's capstone initiatives. Through this major research program, we will develop proliferation-resistant nuclear fuel treatment and transmutation technologies that can reduce the volume and toxicity of spent fuel. We think this is a very important objective.

There are many unique aspects of this program. It involves many of our national laboratories in a comprehensive and integrated fashion. It brings universities, particularly the University of Nevada-Las Vegas and Idaho State University, as key R&D partners. Most importantly, it leverages the experience and expertise of our international partners. Already, simply through signing cooperative agreements, we have gained $100 million worth of research data.

Senator DOMENICI. What is this on and from whom?

Mr. MAGWOOD. Working with our international partners through agreements we signed with France and Korea and most recently the European Union, we have gained access on——

Senator DOMENICI. On what subject?

Mr. MAGWOOD. Advanced fuel cycles.

Senator DOMENICI. Good.

Mr. MAGWOOD. Over $100 million worth of data has been available. This is very important.

GENERATION IV NUCLEAR ENERGY SYSTEMS

For AFCI to be successful, however, it is important that we move forward with Generation IV nuclear power systems. Two years ago, when we launched the Generation IV program to develop advanced reactor technologies, we were able to reach out to the international community. We now have a total of 10 countries in the Generation IV international forum, including the United Kingdom, Argentina, Brazil, Canada, France, Japan, Republic of Korea, Republic of South Africa, Switzerland and, of course, the United States working together on advanced technologies.

The work of the forum has been very intensive and very cooperative. We are very pleased with what we have been able to accomplish. The level of international cooperation has been extraordinary. As an example, a French scientist was assigned to the INEEL for a year to help formulate the Generation IV technology road map. More recently, just this week, in fact, the U.K. Department of Trade and Industry has assigned one of its senior officials, Ms. Helen Wiser, to work at the Department of Energy for the next 2 years. I am pleased to say that she is here with me today to see her first Senate hearing in the United States.

Last year, at a meeting in Japan, the Generation IV National Forum presented Secretary Abraham and other senior officials with the completed technology road map that identifies six important technologies for the future. One of these technologies, the Very High Temperature Reactor, is a technology that we are very interested in exploring. We believe that this technology could be the future source of cost-effective, commercial-scale production of hydrogen, the power of a growing economy, without emitting greenhouse gases and other pollutants.

NUCLEAR HYDROGEN INITIATIVE

That brings me to our other major new initiative, the Nuclear Hydrogen Initiative, which is part of the National Hydrogen Fuel Initiative announced by President Bush. Through this program, we expect to develop and demonstrate by 2007 new technology that can produce hydrogen that could in the future be coupled with Generation IV nuclear power systems. This is very challenging work, but it is work that we believe can and must be done.

NUCLEAR POWER 2010

Finally, it was around this time last year that Secretary Abraham announced the Nuclear Power 2010 Program. This effort is aimed at paving the way for the construction of new nuclear power plants by the end of the decade. We have started cooperative cost-

share projects with three utility companies, Entergy, Exelon, and Dominion Resources, to demonstrate the early site-permitting process. We expect that this joint government-industry effort will result in three applications to the NRC this summer to obtain permits for sites operated by our R&D industry partners.

In 2004, we will work with industry to respond to NRC questions as these applications achieve successful conclusion by 2005. While our tactical and regulatory demonstration work is proceeding well, it is clear that the business and financial issues facing prospective builders of nuclear power plants are the biggest hurdles that need to be overcome. This was highlighted by an independent study commission by the Department from Scully Capital last year. This financial advisory firm found that addressing key financial and business risks associated with building new plants is essential if we are going to see new plants in this country. We are continuing to discuss these risks with industry and hope to make future suggestions as to how those risks can be mitigated.

PREPARED STATEMENT

With that, I will keep my oral remarks brief and look forward to your questions.

Senator DOMENICI. Thank you very much.

[The statement follows:]

PREPARED STATEMENT OF WILLIAM D. MAGWOOD, IV

Mr. Chairman, Senator Reid, and Members of the Subcommittee, it is a pleasure to be here to discuss the fiscal year 2004 budget submission for DOE's Office of Nuclear Energy, Science and Technology.

Over the last 30 years, nuclear power has risen to become the second most important source of electric energy in the United States and at the same time, the most operationally economic. The benefits of nuclear power as a clean, reliable and affordable source of energy are a key to the economic and environmental underpinnings of this Nation. A central mission of the Department's nuclear energy research program is to help enhance the basic technology and, through some of the most advanced civilian technology research conducted today, chart a course to the next leap in technology. In fiscal year 2004, we are proposing a $388 million investment in nuclear research and development and for the Nation's nuclear science, technology and education infrastructure, a 6 percent increase over the current year appropriation.

This budget request responds to the President's priorities to deploy new generation capacity to fortify U.S. energy independence and security while making significant improvements in environmental quality. It builds on the important work started over the last 2 years to deploy new nuclear plants in the United States by the end of the decade, to develop advanced, next generation nuclear technology, to strengthen our Nation's nuclear education infrastructure, and it proposes exciting new priorities.

In fiscal year 2004, we propose to launch the Nuclear Hydrogen Initiative to use high temperature nuclear energy systems for clean hydrogen production as part of the President's Hydrogen Fuel Initiative. We are also proposing the Advanced Fuel Cycle Initiative with research aimed at developing proliferation-resistant fuel treatment and fuel cycle technologies that can reduce the volume and toxicity of commercial spent nuclear fuel and maximize energy from nuclear fuel.

During fiscal year 2002, we pursued significant management reforms in order to implement the President's Management Agenda (PMA), including a major reorganization to better reflect the Administration's priorities, improve overall management and reduce the number of primary organizational units from eight to three. To assure overall accountability, PMA performance measures were cascaded from the Director through our Associate Directors to the staff. We also placed great emphasis on developing meaningful R&D investment criteria and applying the criteria to our nuclear research initiatives. The nuclear program successfully recruited and hired new junior professional staff and we are working to put to new senior manage-

ment team in place at the Idaho Operations Office, who will oversee the Department's activities at the INEEL and lead the continuing transition of this laboratory back to its nuclear research roots.

The NE budget request also supports the infrastructure for production of medical research isotopes, space and national security power systems, and the site and security infrastructure for Argonne National Laboratory-West in Idaho. I will now provide you more detail on our nuclear R&D initiatives and the linkages between them.

ADVANCED FUEL CYCLE INITIATIVE

Of the issues affecting future expansion of nuclear energy in the United States and worldwide, none is more important or more difficult than that of dealing effectively with spent nuclear fuel. After a long and difficult process, the country is moving forward with a geologic repository, and we are on schedule to submit a license application to the Nuclear Regulatory Commission by the end of 2004.

With these successes, we are able to pursue research that can optimize the use of the first repository and possibly reduce the need for future repositories. As one of the Secretary's capstones, the fiscal year 2004 Budget proposes an aggressive research and demonstration program—the Advanced Fuel Cycle Initiative—with an investment of $63 million in fiscal year 2004 to explore advanced, proliferation-resistant nuclear fuel treatment and transmutation technologies that can reduce volume and toxicity of spent nuclear fuel for a geologic repository. If successful, these same technologies offer benefits of enhancing national security by reducing inventories of commercially-generated plutonium and enhancing energy independence by recovering the energy value contained in spent nuclear fuel.

The Department is proposing a research program leading to demonstrate proliferation-resistant fuel treatment technologies to reduce the volume and radioactivity of high level waste, and the development of advanced fuels that would enable consumption of plutonium using existing light water reactors or advanced reactors. With the President's request, the Department will continue work toward demonstration of proliferation-resistant fuel treatment technology and continue design of transmutation fuels for future use with current reactor technologies.

For the Advanced Fuel Cycle Initiative to be successful, advanced fuel treatment and transmutation research and development must be integrated with the development of Generation IV nuclear energy systems, particularly with those reactor technologies that can produce very high energy neutrons that would be needed to transmute a wide variety of toxic radioactive species. To support this goal, the Advanced Fuel Cycle Initiative will develop the advanced proliferation resistant fuels and fuel cycle systems for Generation IV reactors.

GENERATION IV NUCLEAR ENERGY SYSTEMS

Two years ago, we launched the Generation IV program to develop advanced reactor technologies for commercial deployment after 2010 but before 2030. These advanced reactors offer significant advances in sustainability, proliferation-resistance, physical protection, safety and economics. Development of these reactors is being pursued by the Generation IV International Forum, a group of ten leading nuclear nations (United Kingdom, Argentina, Brazil, Canada, France, Japan, Republic of Korea, Republic of South Africa, Switzerland, and the United States), which last year selected six promising technologies for joint research, development, and demonstration. While the Department has not yet decided upon which of these technologies it will eventually focus, all of the technologies are of considerable interest. The six innovative, next-generation technologies include two gas-cooled reactors, one water-cooled reactor, two liquid-metal-cooled reactors, and a molten salt-based reactor concept.

Key research objectives for these technologies will include such activities as demonstrating advanced fuels and materials. The goal of the initiative is to resolve the fundamental research and development issues necessary to establish the viability of these concepts. By successfully addressing the fundamental research and development issues, the concepts are highly likely to attract future private sector sponsorship and ultimate commercialization. In fiscal year 2003 and fiscal year 2004, the Department will establish international partnering agreements to guide joint research and begin research and development on several of the reactor concepts, including very high temperature reactors that would support cost-effective production of hydrogen.

NUCLEAR HYDROGEN INITIATIVE

Generation IV is closely linked to our new Nuclear Hydrogen Initiative, aimed at demonstrating economic commercial-scale hydrogen production using nuclear en-

ergy. Today, through electrolysis, we can convert water to hydrogen using electricity but we believe that for the future, very high temperature reactors coupled with thermo-chemical water splitting processes offer a more efficient technology for production of large quantities of hydrogen, without release of greenhouse gases.

The hydrogen initiative grew out of the success of our Nuclear Energy Research Initiative, in particular, two investigator-initiated projects that identified a number of advanced reactor concepts capable of producing large quantities of hydrogen with high efficiency and low cost. Since then, we have awarded three additional NERI projects to study nuclear production of hydrogen. Beginning this year and under the international component of NERI (I-NERI), we are working in cooperation with Commissariat d'Energie Atomique (CEA) on a three-year effort to develop laboratory scale demonstration of the thermo-chemical water splitting process.

The funds provided in fiscal year 2003 will allow us to accelerate the Nuclear Hydrogen Technology Roadmap so that by fiscal year 2004, we would begin implementing the research and development that is defined by the roadmap. We would also continue exploring laboratory scale demonstration of some of the key processes involved in nuclear hydrogen production, such as other thermo-chemical water splitting processes or high temperature electrolysis as well as development of high temperature heat exchangers.

NUCLEAR POWER 2010

The President's budget supports continuation of Nuclear Power 2010 in fiscal year 2004 to demonstrate, in cost-shared cooperation with industry, key regulatory processes associated with licensing and building new nuclear plants in the United States by the end of the decade. As concluded in a business case study conducted in 2002 by financial advisory firm Scully Capital, addressing key financial and business risks associated with building and licensing the first few nuclear plants is essential to proceeding with new nuclear plants in the United States.

In fiscal year 2004, the requested funds will continue to support the activities associated with submitting and achieving Nuclear Regulatory Commission (NRC) approval of early site permits and development of Combined Construction and Operating License applications.

Last year, the Department initiated cooperative cost shared projects with three generating companies—Entergy in Mississippi, Dominion in Virginia, and Exelon in Illinois, to demonstrate the new regulatory process for siting new nuclear power plants. These companies are pursuing applications for Early Site Permits for new plants at sites where they currently operate nuclear power plants—at Entergy's Grand Gulf site, Dominion's North Anna site, and at Exelon's Clinton site. The Early Site Permits will be submitted to the NRC by the end of this fiscal year and in fiscal year 2004, we will continue our support of these regulatory demonstration projects to achieve successful NRC staff review and approval of the siting application in 2005.

Key to the deployment of new nuclear power plants, besides a viable site, is selection of a nuclear power plant design and utility application for a combined Construction and Operating License from the NRC. In fiscal year 2003, the Department will solicit and award industry cost-shared projects to implement activities to achieve deployment of new nuclear power plants. This effort includes the necessary analysis and planning for technology selection and project cost determination, additional siting activities as appropriate, advanced reactor development and certification, and demonstration of the combined construction and operating licensing process.

UNIVERSITY REACTOR FUEL ASSISTANCE AND SUPPORT

The Department sponsors the University Reactor Fuel Assistance and Support initiative, which supports the enhancement of the U.S. nuclear science and technology educational infrastructure. The need for trained and qualified nuclear scientists has not diminished over the years, and in fact, because of increasing retirements in the nuclear field, demand today exceeds supply.

We are very pleased that the President's budget includes $18.5 million for this program for fellowships, scholarships, nuclear engineering research, and for critical support to university research reactors. In fiscal year 2002, the Department launched the Innovations in Nuclear Infrastructure and Education program, encouraging universities to form ground-breaking partnerships with national labs, the private sector, and other universities to strengthen nuclear engineering education and optimize the use of research reactors. In fiscal year 2002, DOE issued awards to four consortia of universities and their partners. In fiscal year 2003, DOE will be able to support an additional award and will continue support for this program in fiscal year 2004.

RADIOLOGICAL FACILITIES MANAGEMENT

This budget request also includes $63 million in funds to maintain critical research, isotope and space and national security power systems facilities at Oak Ridge National Laboratory, Los Alamos National Laboratory, Sandia National Laboratory, and Brookhaven National Laboratory in a safe, secure, and cost effective manner to support national priorities.

The fiscal year 2004 budget request also includes $13 million in funds transferred from the National Nuclear Security Administration to continue the Uranium–233 project at Oak Ridge National Laboratory. This project is aimed at stabilizing materials left over from the Cold War to address a Defense Nuclear Facilities Safety Board recommendation, while extracting isotopes from the uranium that are needed for very promising medical research.

INEEL—DOE'S COMMAND CENTER FOR NUCLEAR R&D

Finally, this budget supports the Secretary's realignment of the mission of the Idaho National Engineering and Environmental Laboratory to focus the future of the site on nuclear research and development. As the Department's leading center of nuclear research and development, this laboratory is the "command center" for our efforts to develop advanced reactor and fuel cycle technologies, including development of space nuclear power and propulsion technologies.

While the nuclear energy program involves the collective talents of universities, the private sector, international partners, and our national laboratories—Argonne, Los Alamos, Sandia, and Oak Ridge among them—the rebuilding of the Departments' nuclear program underway today would not be possible without the dedicated scientists, engineers and supporting staff of the Idaho National Engineering and Environmental Laboratory.

Clearly, environmental cleanup will remain a major focus of the Department for the near-term but real progress is being made that will clear the way for expansion of nuclear research and development. With this year's budget, $110 million has been transferred from the environmental cleanup program to the Department's nuclear program to manage laboratory infrastructure and security.

This year's budget request combines the infrastructure for the INEEL previously funded by the Office of Environmental Management, for the Test Reactor Area landlord, and for the infrastructure of Argonne National Laboratory West under the Idaho Facilities Management program. Similarly, the Safeguards and Security program, combines the security funds INEEL and Argonne-West, into a single program. With significantly challenges to security since September 11th, we are very pleased that our current-year appropriation is substantially higher than last year and that the fiscal year 2004 request, at $54 million, is about 13 percent higher than this year.

CONCLUSION

Mr. Chairman, and Members of the Subcommittee, this concludes my prepared statement. I would be pleased to answer any questions you may have.

Senator DOMENICI. I have a series of written questions which we will submit. We would appreciate your answering them as soon as you can.

And we would like to just talk with you for a little while here. Dr. Orbach, about 5 years ago, a number of science initiatives directed at the lagging activities of the United States in nuclear energy and nuclear activities were started by this subcommittee. One of the least noticed but most important is the study, which you were in charge of, to evaluate the low-level radiation and its actual effects rather than the formula-extracted radiation expectations that have been in existence for a long time using linear projections.

Can you talk about that study for a minute? How is it going? And are you certain that it is moving ahead such that when we are finished, those who have never wanted this done and always thought we should stay stuck on that linear formula will be satisfied that it is done neutrally by peer excellent scientists?

Dr. ORBACH. Yes, we currently have 53 research projects at laboratories and universities on low-level radiation. We have learned already that your last comment is correct, namely that the extrapolation from the high-end radiation to low doses simply is not accurate, does not work, and misses the essential biology. We found already in our probes and our research programs that there are intercellular activities that take place. One cell influences another. So the conventional idea that radiation would act only on the DNA of a particular cell simply does not hold up at these low levels. We have been able to look at adaptive responses, how cells adapt to radiation, bystander effects, how cells adjacent to cells that suffer radiation damage are affected. Individual genetic responses to radiation at this level are very different, and there may well be a genetic difference among individuals. We are mathematically modeling radiation risk, as well.

We have received about 50 proposals for new research that will be peer reviewed later this spring. New emphasis for this research is to look at whole systems, rather than single cells. This peer review process will be done fairly and independently. As a consequence, those projects selected will be on the basis of scientific merit alone.

Senator DOMENICI. But, Doctor, while I appreciate your knowledge on it and the fact that it is very widespread and exciting, on the other hand, the importance of this is to determine at a point in time, sometime, whether or not that formula is the right one to be using for low-level radiation doses.

As you know, that formula has supplied the information for nigh on decades now as to what the negative effect might be of a certain dosage of low level radiation. The consequence of that might not seem like much, as we discuss here, but it is generally perceived as dramatic in America.

It determines how much cement you have to put on a site that has once been exposed to low level radiation, so there is no fear on the other side of it. It establishes cleanup standards for all of the waste sites, because there has been such enormous fear that if that formula has been used and what we have done by way of spending money and the like to assure safety is rather extravagant even to an undisciplined eye and ear and mind, and now we have to kind of prove it over the years or we have the constant excessive costs that are attributable to the residue of nuclear activity.

So where are we in that regard? Five more years? Ten more years? Will we come to some finality, as I have described it here?

Dr. ORBACH. I believe we will achieve a finality. I would like to provide for the record our best estimate of when we might be able to achieve that. What we have already discovered is what you have just stated, namely that the extrapolation is not an accurate way of describing the effects of low-level doses of radiation. To make that quantitative into standards of the sort you described, I would——

Senator DOMENICI. It would be awhile.

Dr. ORBACH [continuing]. Need to look at it, and I will respond back to you with that.

[The information follows:]

LOW DOSE RADIATION RESEARCH PROGRAM

The Low Dose Radiation Research Program has the challenge of conducting research that will inform the development of future national radiation risk policy for the public and the workplace. The Program has challenged scientists to quantify and understand the mechanisms of molecular and cellular responses to low dose exposures to radiation, currently 0.1 Gee (10 rads) or less, doses well below those previously studied using older, less sensitive research tools. Indeed, for the first time, some of our scientists have actually been conducting research at radiation doses that overlap or approach the maximum allowable radiation doses above background for the public (100 mrem/year above background) or for nuclear workers (500 mrem/year above background).

Mathematical models are, and will continue to be, used to predict health risks from low doses of radiation by "integrating" information obtained from human epidemiologic studies and from laboratory research. Beginning in 1999, we asked an initially skeptical research community to study biological effects at very low doses. They have risen to the challenge with increasingly important and relevant ideas submitted and progress made each year. Most scientists in the field believe that we still do not know enough about the biological consequences of low dose radiation exposure to be able to completely model human health risk. However, this year the Low Dose Program is challenging scientists in the risk modeling community to begin a systematic evaluation of how the new data from research in this program can (or cannot) be used in new mathematical models that estimate the health risks of low dose radiation exposure. The program issued a call for new research, DOE Notice 03–20, on February 19, 2003, that builds on our previous research and is designed to jump start this process of biologically-based risk modeling. This exciting new research opportunity will also provide valuable feedback on additional laboratory research that is needed to make biologically-based risk modeling a reality.

Our best estimate of the time required to reach sufficient understanding of the biological consequences of low dose radiation exposures to resolve the uncertainty and controversy surrounding the use of the linear no-threshold model is based on current budget levels, progress we have made to date, and the anticipated progress of current and future research. The new modeling research that will be funded later this year will require approximately 1½ to 2 years to complete. The results of this research will lead to new laboratory-based research aimed to fill remaining critical gaps in the information needed to develop the new biologically-based risk models for radiation exposure, a process that typically takes 3 years. Finally, results of this research will again be used to develop improved biologically-based risk models. Under current levels of funding, we estimate a total of 6 to 7 years is required to accomplish the research described above.

Given budget uncertainties as well as the uncertainties of research, progress could be somewhat faster or slower. As scientists, we never know if the next experiment will yield an unexpected breakthrough. If one or more critical breakthroughs occur over the next few years, progress could certainly be faster. At the same time, we cannot know for certain prior to the completion of ongoing and planned research if additional research will be necessary. If another round of laboratory research and modeling is required at the end of the process described above, it could, instead, be closer to 10 years before we have a definitive answer. We are certainly encouraged by progress that has been made to date and anxiously await the research results that will be forthcoming in the future.

Senator DOMENICI. I would like to know that. And, sir, I would also like to know that for those who have complained about it not being the right way to do it—and I would like to hope that every step of the way you have gone to the scientific community and attempted to get the right answer. See, this is the real Achilles heel for the anti-nuclear people. The anti-nuclear people do not want this study to succeed, because so long as that formula is used, it is enormously expensive to do anything that has low-level radiation.

And if it is wrong, which most scientists say it is, we ought to conclude that it is. So some would like you not to succeed. And I

urge you, as the head person, to be aware of that and make sure that it is succeeding.

Dr. ORBACH. I commit myself to that. This is a study based solely on the science, on the quality of the science. And the judgments will be on that basis alone.

Senator DOMENICI. Now you have another part of the science—Senator, would you like to participate? Do you want to make an opening statement or ask questions?

Senator DORGAN. No. I am just listening to you. As soon as you are finished, I will ask some questions. But why do you not proceed?

Senator DOMENICI. Thank you.

NANOSCIENCES

You have another very exciting activity within your domain of the nanoscience centers. Now there is no question that scientists that know, obviously including the great Dr. Davis who you have alluded to from Rice University, I believe, that got the Nobel because of research on nanoscience—and that was in the very early stages, very early determinations. But they have all concluded that this is something very fundamental in terms of its capacity to offer new and exciting things to be done and ways to do things going beyond the atomic structure that we currently assume is part of everything. We go inside of it, which is the nano part.

Now we have five centers. One is in my State, a combination of Sandia, Los Alamos, an Air Force laboratory? Then you have four more?

Dr. ORBACH. Yes.

Senator DOMENICI. Now are you in charge of those centers, or how are they being managed?

Dr. ORBACH. Yes, my office is in charge of those centers. They are administered through the Basic Energy Sciences Program within the Office of Science. All five of those centers were accomplished through, again, a peer review process. Each of them have held open workshops of the order of 400 scientists coming to each of the workshops. We have just had a very large meeting last week in Washington to talk about the initiatives.

Each of the five, although, obviously, there has to be overlap, because some of the fundamentals are similar, choose their own areas of expertise where they can make the greatest contribution. The two laboratories in your State, for example, will be looking at the nano electronics area. This is because of the extraordinary expertise that both Los Alamos and Sandia have in that area. They will be looking not only at electronics, but also photonics, at the nano scale.

So what we do is to build on the local strength of the laboratories to focus on specific areas of interest. The Luhan Center at Los Alamos is now the largest spallation source for neutrons in the United States, and that is closely coupled to the nanotechnology initiative. So we can do, not only statistics, but also dynamics in situ while the materials are being grown.

We also are pursuing similar approaches using our light sources, or the spallation neutron source that is under construction at Oak Ridge.

So each of the centers has its own flavor and its own focus. This will give the United States leverage over any other country in the world because, where it is true that each country is investing in what I call table-top nanotechnology, the United States is using very large facilities in intimate relationship to the nanotechnology growth and determination, physical property determination, centers so that, as we grow them, we can study their properties.

This is something that no other country will have access to on their own soil and will give, we believe, American scientists and engineers and our companies a great advantage.

Senator DOMENICI. And those centers are funded, albeit in small amounts, in this budget.

Dr. ORBACH. Yes, the three centers are funded for construction, including the one in New Mexico. The other two centers are either in the engineering design stage at Brookhaven National Laboratory, or we have an arrangement with the State of Illinois where they will build a building at Argonne and we will provide the equipment.

So the latter two are in the initial stages. By 2008 all five laboratories are expected to be up and running.

Senator DOMENICI. They had a meeting here, did they not, pretty recently, the nanoscientists?

Dr. ORBACH. Yes, indeed.

Senator DOMENICI. I was there.

Dr. ORBACH. I think you were one of the principal spokesmen.

Senator DOMENICI. Let me ask, on the other part of little things, microengineering, is that a specialty within the Department, or are those things being done just by the laboratories on microengineering or micromachines?

MICROMACHINING

Dr. ORBACH. The micromachining is an integral part of this. It is a way of getting down to the nano scale.

Senator DOMENICI. Yes. I understand.

Dr. ORBACH. It is being funded by ourselves, as well, yes.

Senator DOMENICI. Have you seen a micromachine put on a chip?

Dr. ORBACH. I have seen the micromachines producing chips. I do not think I have seen one on a chip. That is wonderful.

Senator DOMENICI. Have you seen—you have not seen a micro engine working on a chip?

Dr. ORBACH. Oh, yes, indeed. You can produce little motors now at the micron level or submicron level, which is very exciting.

Senator DOMENICI. And you know how you have a chip now that has all the different things we talk about being on there? Micromachines are now so small and so controlled that you take a piece of material, much like the foundation of a chip, and you put on it scores and scores of little, tiny engines. And they are called microengines. And when they put the proper machinery on it to expand the size, you can actually watch these little, tiny, tiny machines work. They work just like a turbine, in and out. And they are trying to figure out in due course what you will use them for.

Dr. ORBACH. Oh, these have phenomenal applications. For example, in medicine——

Senator DOMENICI. Right.

Dr. ORBACH [continuing]. These machines can be placed inside the body at the cellular level.

Senator DOMENICI. Right.

Dr. ORBACH. Very exciting.

Senator DOMENICI. And you may properly instruct the machine so that, for instance, they will remove the plaque in your heart instead of having surgery. At least they are thinking about that kind of thing.

Let me complete just two more questions, and then move to nuclear. And then I will yield to the Senator.

Let us talk about nuclear for a minute, one more with you. Who is in charge more or less of moving ahead to see that the United States is not, on the one hand, moving with a hydrogen engine and on the other hand leaving us without a way to make hydrogen in large quantities? We do not find hydrogen around. We have to go make it.

And my understanding is, right now, there are only a couple ways to make it. One is natural gas. And we surely would not want to do that, I would not think. By creating huge new uses, there is going to be a shortage of natural gas soon. And the other would be some kind of nuclear reactors. Is that your area, or your area, or whose?

HYDROGEN

Mr. GARMAN. Actually, we are working on it together.

Senator DOMENICI. Who is together?

Mr. GARMAN. In the Department of Energy, the Office of Science, the Office of Energy Efficiency and Renewable Energy, the Office of Nuclear Energy, and the Office of Fossil Energy are all working together in a coordinated way. We have, in fact, been producing what we call our hydrogen posture plan, which is a way to describe to the Congress and the world precisely how we are working together to tackle some of the daunting technological challenges that we face, not only in production, but in storage.

There is no one entity in the Department that should do that. We do hydrogen, but we depend on the work in his lab, for instance, to find a breakthrough in a hydride material to solve a storage problem. So we are going to work very closely together on all of these issues.

Senator DOMENICI. Well, it should not surprise you, if we do an energy bill, and we are well on the way to having one written, we are surely going to have a major section on the research and development of the car engine and whatever the United States is going to need to produce the hydrogen in the future.

Senator DORGAN. Senator, would you mind if I could ask a question about that?

Senator DOMENICI. Go ahead.

Senator DORGAN. I have to be upstairs at 3:30.

Senator DOMENICI. Sure.

Senator DORGAN. If I would be able to ask a question following up on the one you just asked——

Senator DOMENICI. Go ahead.

Senator DORGAN [continuing]. And then perhaps one of Dr. Orbach, as well.

The issue of hydrogen production is one in which you can produce hydrogen from natural gas. You can also produce hydrogen from nuclear. But hydrogen is ubiquitous. It is everywhere. You can produce hydrogen through electrolysis by separating the hydrogen and oxygen in water. In fact, this past weekend I rode on a commercial bus that was on the city streets of a city out west that was a fuel cell bus being powered by hydrogen. The supply of hydrogen on a demonstration basis came from several different sources; one from solar energy, second from electrolysis, third from natural gas. And there are many other ways to produce hydrogen, as well.

But Mr. Garman is quite correct, that we need to evaluate both production, transportation, and storage, all of which are important in moving towards this area.

And I agree with you, Mr. Chairman, that stationary engines are important, as well as the issue of how to use fuel cells to power vehicles. And I am really anxious to work with you on this. I think we can make a real difference, both on the Energy Committee and also on the Appropriations Subcommittee dealing with these issues.

Senator DOMENICI. We will.

Senator DORGAN. The President has put his administration on course in support of this, which I think is very important. I have indicated I think it is timid in terms of funding, but I do not mean that as a heavy criticism, because it is no small feat to have this administration say, "Let us move in this direction." I just want to make that point, because I am very excited about this and want to work with Mr. Garman and you and others on it.

Can I just ask a question about the funding of other renewables? I asked you the question the other day, Mr. Garman, and indicated my concern about reduction in funding of biomass, level funding or slightly reduced funding in solar, wind, and some other areas. Has the decision to move toward fuel cells or a hydrogen-based economy meant that you have had to reduce what otherwise would have been provided for other renewables?

OTHER RENEWABLES

Mr. GARMAN. No, sir. I do not believe it has. We looked at each of these programs independently. After you apply the congressionally-mandated reductions to the 2003 levels, funding for solar is down $4.1 million. But we still have $80 million to work with. Funding for wind is down $700,000. So we still have a very robust request in this area. In hydropower, funding is actually up a couple million dollars. And in geothermal funding, it is down $3.4 million. But again, we still have a robust $25.5 million program to work with.

We do have a significant reduction in the biomass program of some $17 million in this account. That is substantial. We think that with the availability of the Department of Agriculture money, which was not available to us before, and the fact that we are revamping and restructuring this program to achieve greater results with the money we have, we have a very strong and vibrant biomass program. The biomass program is emerging to be the strongest it has been in years.

Senator DORGAN. Well, some of us want to watch those renewable programs carefully. I am pleased you are there. I have a lot of confidence in your ability.

Mr. Chairman, Mr. Garman came out to North Dakota and spoke to a wind energy conference. Seven hundred and fifty people showed up at a wind energy conference. They are very, very interested in the possibilities there.

So, Mr. Garman, I look forward to working with you on a range of these issues.

I would like to ask Dr. Orbach, you were at Riverside, as I recall——

Dr. ORBACH. Yes.

Senator DORGAN [continuing]. Prior to this appointment. And we have talked previously about micro and nanotechnologies. I note the five centers. And I note the granting process that you are involved in with grant funds. You are well aware of my concern about where the grants in this country go from the Federal Government. We have a process that is kind of a perpetual process of renewal. Those large institutions that get the grants will always get the grants, because they are the major part of the peer review of who is going to get grants in the future.

If you take California, Texas, Massachusetts, and New York and take a look at the amount of research money that goes from the largest researcher in the world, that is, the Federal Government, to those States, it predicts where future economic opportunities and future centers of excellence will be. And so I am very concerned about making sure that the great talents in the rest of the country are put to use on micro and nanotechnologies, as we proceed. And I know you are familiar with that, given the work that you were interested in at Riverside. I hope that you will keep that in mind in your current position as well.

In your testimony, you say the two major achievements for 2002, and you talk about them. Can you give me a notion of what you think you might be telling the committee next year about the two major achievements for 2003? What is out there that you think is really fascinating, right on the edge, that is going to be something that represents significant breakthroughs?

SCIENCE ACHIEVEMENTS

Dr. ORBACH. Well, if I could address the first part of your question, because I feel very strongly about it. Our responsibility in our office is to our Nation. If we are not careful, we are going to leave States behind in economic development. I have been working very hard through EPSCoR through the other programs we have in the Federal Government, to encourage economic development for every State.

Your State has some absolutely first-class people and investments. The investment that I visited personally at North Dakota State University was impressive. Your Caterpillar relationships up there already show that you can work and work well.

The program I was involved in was a sharing program between the North Dakota State University and the University of California Riverside. That program is underway. We are encouraging in the nanotechnology area scientists from all over the country to partici-

pate. And it is hard when the facilities are not available immediately and locally. So we are encouraging partnerships to enable that to happen. You will see me work very assiduously on the spreading of economic development opportunities across this Nation. Otherwise, we will leave States behind, and that is not acceptable.

If you ask a scientist what is going to happen in a couple of years, it is always with some trepidation that they will respond, because we have been wrong so often in our expectations.

I can say that there will be something exciting at this hearing next year. My guess is that it will be in the biological area, for example, Genomes to Life. The work there on hydrogen production, carbon sequestration, the new initiatives that we are looking at in the nanotechnology area in biology are going to be extraordinary.

Some of our large machine designs are also coming along. The light source at Stanford, which is a free electron laser, will increase the intensity in the X-ray, hard X-ray region by 10 orders of magnitude. We may enable biologists to be able to look at a single molecule and determine structure, rather than having to grow a single crystal, as they do now.

Senator DORGAN. Do you have one publication, Dr. Orbach, that describes some of the really interesting areas of research?

Dr. ORBACH. Yes, we do. I would be delighted to provide that to you. Thank you.

[The information follows:]

ACCOMPLISHMENTS AND AWARDS

BASIC RESEARCH WITH HISTORIC RESULTS

The Office of Science maintains our Nation's scientific infrastructure and ensures U.S. world leadership across a broad range of scientific disciplines. It supports research and development programs enabling the Department of Energy to accomplish its missions in energy security, national security, environmental restoration, and science.

Office of Science research investments have yielded a wealth of dividends, including significant technological innovations, medical and health advances, new intellectual capital, enhanced economic competitiveness, and improved quality of life for the American people.

Research supported by the Office of Science has made major contributions to development of the Internet; magnetic resonance imaging (MRI) and medical isotopes; composite materials used in military hardware and motor vehicles; and x-ray diagnostics of computer chips and other high-tech materials.

Office of Science research investments also have led to such innovations as the Nobel Prize-winning discovery of new forms of carbon, non-invasive detection of cancers and other diseases, improved computer models for understanding global climate change and new insights on the fundamental nature of matter and energy.

Research sponsored by the Office of Science has produced many key scientific breakthroughs and contributed to this Nation's well-being:

—Helping to Develop the Internet
—Computing for Science's Sake
—Pioneering the Human Genome Project
—Expanding the Frontiers of Discovery
—Improving the Science of Climate Change Research
—Enhancing National Security
—Improving Energy Security
—Medical Imaging
—Restoring Sight to the Blind
—Enabling World-Class R&D

HELPING TO DEVELOP THE INTERNET

The Office of Science helped develop the Internet. Really!

In 1974, the Office of Science first connected its geographically dispersed researchers through a single network, a revolutionary, cost-effective mechanism that provided supercomputing power to civilian researchers and established a network model adopted by other Federal Government agencies and States for their researchers.

Later, the Office of Science collaborated with DARPA, NSF and NASA to transform the many independent networks of the 1980's into a single integrated communications network that was the basis for today's commercial Internet.

More recently, the Office of Science created the multicast backbone (M-Bone), the Internet videoconferencing virtual network that launched a new era in scientific collaboration in the early 1990's by linking anyone with a workstation with audiovisual capabilities and a high-speed connection to the Internet.

COMPUTING FOR SCIENCE'S SAKE

The Office of Science long has been respected as the world leader in developing and using advanced computers as tools for scientific discovery and to achieve breakthroughs in targeted applications disciplines.

It pioneered the transition to massively parallel supercomputing (involving 1,000 or more processors), producing the software, scalable operating systems and other technologies needed and demonstrating its value in fields ranging from seismic imaging to materials modeling.

The Office of Science also installed the first supercomputer available to the civilian research community that broke the peak performance barrier of 1 teraflop—or a trillion operations per second—and developed the first civilian scientific application to achieve actual performance over 1 teraflop.

PIONEERING THE HUMAN GENOME PROJECT

The Office of Science initiated the Human Genome Project in 1986.

It also developed DNA sequencing and computational technologies that made possible the unraveling of the human genetic code and published a complete draft of the DNA sequence of the human genome in 2001.

This historic undertaking to discover the genetic blueprint of human beings will enable scientists to identify more genes responsible for diseases and develop new and diagnostic and treatment possibilities.

Now the Office of Science is harnessing the biotechnology revolution to develop clean energy and repair damage to our environment through the Genomes to Life Initiative.

EXPANDING THE FRONTIERS OF DISCOVERY

The Office of Science funded the research that led to one of the great intellectual achievements of the 20th century: the discovery of all but one (the electron) of the most fundamental constituents of matter, namely quarks and leptons, which confirmed the Standard Model—physicists' current theory of matter and the forces of nature—and led to 13 Nobel Prizes.

The Office of Science supported the 1996 Nobel Prize-winning discovery of a new form of carbon, known as "Bucky Ball," which is spurring a revolution in carbon chemistry and may lead to a profusion of new materials, polymers, catalysts, and drug delivery systems.

Now the Office of Science is underwriting research to solve the mystery of "dark energy," perhaps responsible for the remarkable recent finding that the expansion of the universe is accelerating, rather than slowing due to gravity as expected.

IMPROVING THE SCIENCE OF CLIMATE CHANGE RESEARCH

The Office of Science initiated the Climate Change Research Program in 1978 to evaluate the environmental and health consequences of long-term energy solutions. This was the first research program in the U.S. to investigate the effect of energy-related emissions of greenhouse gases, especially carbon dioxide, on climate and the environment.

The Office of Science also has developed software and computer systems to model and simulate environmental conditions and project climate change under varying emissions scenarios.

The Office of Science's climate change research program is the third largest in the United States—and the only one that is focused specifically on improving the scientific basis to understand, predict, and assess the effect of energy-related emissions on climate and the environment.

ENHANCING NATIONAL SECURITY

The Office of Science has funded research leading to technologies that make our lives safer in many ways. These include:

—neutron detectors that can identify concealed nuclear weapons and land mines and are used for arms control and nonproliferation verification;

—new holographic computerized imaging technology that identifies hidden weapons, even non-metallic ones, through the clothing of airline passengers;

—smoke detectors that sense smoke by detecting changes in the ionization of the air; and

—advanced sensors that can detect explosives, narcotics, and chemical and biological agents—and many other innovations that will contribute to homeland security.

IMPROVING ENERGY SECURITY

The Office of Science has contributed to improved energy savings through several discoveries, including:

—lithium batteries that offer high-energy storage capacity and an environmentally benign alternative to the harmful lead used in conventional batteries;

—new and improved metals, plastics and other composite materials used in military hardware and motor vehicles; and

—superconducting wires that can lead to more efficient types of power generation, transmission, and electrical devices—and thereby save energy and reduce emissions.

In addition, the Office of Science's research into fusion energy is poised to pay big dividends. Scientists are figuring out the way the sun and stars produce their energy—and that can have broad applications for mankind, since fusion power holds important promise as a clean, inexhaustible energy source.

MEDICAL IMAGING

The Office of Science is responsible for key advances in positron emission tomography (PET) and magnetic resonance imaging (MRI), which permit non-invasive and improved detection and diagnosis of medical conditions.

RESTORING SIGHT TO THE BLIND

The Office of Science is now sponsoring research and development of an artificial retina, which can restore sight in blind patients with macular degeneration, retinitis pigmentosum, and other eye diseases.

A microelectronic chip implanted in the eye captures light signals and visual information, bypasses damaged photoreceptors, and electrically stimulates viable layers of the retina, thereby enabling the blind to see.

ENABLING WORLD-CLASS R&D

Throughout its history, the Office of Science Development has designed, constructed and operated many of the most advanced research and development facilities in the world, which keep the United States in the forefront of scientific discovery and technological innovation.

These include neutron scattering facilities, synchrotron radiation light sources, the superconducting Tevatron high-energy particle accelerator, the world's first linear collider, the continuous electron beam accelerator, the relativistic heavy ion collider (the highest-energy "atom smasher" in the world) and a Tokamak fusion test reactor.

[CLERK'S NOTE.—Attachments included with the preceding information have been retained in subcommittee files.]

Senator DORGAN. Well, let me again say I will be anxious to work with you.

And, Mr. Chairman, thank you for allowing me the opportunity to——

Senator DOMENICI. You are welcome.

I noticed when you mentioned the location of these science facilities, you mentioned the four big States. One little State does all right, New Mexico.

Senator DORGAN. I just did not want to advertise it.

But I know how well New Mexico does, Mr. Chairman.

Senator DOMENICI. That is because we have those big nuclear laboratories and have to put up with all that nuclear stuff for so long. Such a terrible burden; that is what some people think. They want to close them up. If they have any more Los Alamoses or Sandias, open them up in our State. That would be fine.

I am just kidding, you understand.

Let me just say to all of you that I am very, very pleased with the way the whole Department is growing in terms of science. I am somewhat concerned that we move ahead as quickly as possible in the nuclear research areas, because there seems to me to be no way out for us and for the world but to find a new generation of nuclear power plants.

And, Mr. Magwood, I know that you are charged with that. And we will try in our new energy bill to even broaden that authority and move on with it. You are charged under the Energy Department to move ahead with the next generation. You call it nuclear power IV. What does that phrase mean in terms of moving ahead with that research?

GENERATION IV NUCLEAR ENERGY

Mr. MAGWOOD. I think you are referring to the Generation IV Nuclear Energy Systems Initiative.

Senator DOMENICI. Correct.

Mr. MAGWOOD. While we have very good technologies available today that are available to the market, the technologies such as the AP 1000, the ABWR from U.S. companies, and others that are available internationally, there is a prospect that we might be able to develop new advanced technologies that deliver on the original promises of nuclear energy, that is, technologies that are incredibly safe and present no conceivable hazard to people outside of the plant site, technologies that are extraordinarily economic and competitive even with natural gas, and technologies that eliminate the issues about proliferation.

We believe this is possible in a new generation of technologies. What we have accomplished so far is that the international community has agreed on what those technologies might be. Now is the time, as you have mentioned, to move from the planning stage, now that we have decided what those technologies could be, to the laboratory and ultimately to the field to prove that these technologies work.

Senator DOMENICI. Well, do you feel comfortable with the level of funding in the budget? Are there one or two items that you would like to share with us, either on the record or later, that are of importance to you with reference to being underfunded, as far as moving us forward in the nuclear area?

Mr. MAGWOOD. We really are on the very beginning of what I think is a very exciting time for our activities. There are things that we will be able to do as time goes on that will require more funding. For where we are right now, I think we are doing okay. I am very pleased with the budget request that we have put forth. I believe that as our plans become public, there will be opportunities in the future that will require additional resources, but I think well-deserved resources.

DOMESTIC ENRICHMENT

Senator DOMENICI. Let me just stay with you for a minute. The Department has commented on the need for a new domestic enrichment capacity as a means of maintaining a reliable and economical U.S. enrichment industry. One of the ventures that is being bantered around as an opportunity to accomplish this is led by the European consortium of Urenco, a company with a proven record in centrifuge enrichment technology. I know that you are familiar with that company and with that process, are you not?

Mr. MAGWOOD. Yes, I am.

Senator DOMENICI. Do you have any concern that the efforts of Urenco to build a new facility in the United States would in any way pose a national security concern?

Mr. MAGWOOD. No, none at all.

Senator DOMENICI. Do you believe that the development of new enrichment capacity is sufficiently important to the United States, as far as our energy security, that the development of this facility by Urenco should be encouraged and facilitated by the Department of Energy?

Mr. MAGWOOD. Absolutely. We are doing everything we can to help at this stage.

Senator DOMENICI. That is already happening.

Mr. MAGWOOD. Yes.

ADDITIONAL COMMITTEE QUESTIONS

Senator DOMENICI. I thank you. And I thank all of you. And the questions we give you, please answer them as soon as you can.

[The following questions were not asked at the hearing, but were submitted to the Department for response subsequent to the hearing:]

QUESTIONS SUBMITTED BY SENATOR PETE V. DOMENICI

INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR PROJECT WITHIN FUSION

Question. Dr. Orbach, each of the sub-programs funded under your office are looking and planning towards substantial new research investments or construction of the "next big user facility" that will occupy the construction wedge that has been filled in recent years by the SNS construction project, and will be filled in the next few with the construction of the nanoscale science centers. Almost all of these projected expenditures are beyond what is contemplated in the projected baseline for the Office of Science. I would like to go over some of those with you.

Dr. Orbach, you've outlined the Administration's recommendation for the United States to rejoin the international fusion energy experimental program, called ITER (for the International Thermonuclear Experimental Reactor.) Our participation in ITER will cost $1 to $1.5 billion over the next 10 years. The Administration has proposed taking a very timid step down that path by requesting only $2 million for fiscal year 2004. When will the big expenditures come?

Answer. Assuming that the negotiations proceed as planned, construction of ITER is currently planned to start in 2006, so we would expect to request construction funding in our fiscal year 2006 budget proposal. Also, the Administration has requested $12 million for fiscal year 2004.

Question. Why should the Congress or our international partners for that matter, believe the Department will secure the resources to both make our international contributions and maintain a healthy program here in the United States?

Answer. Secretary Abraham has stated publicly his intention to request additional funds for the construction of ITER as well as for the maintenance of a robust domestic fusion program. Further, President Bush said on February 6, in the context of the Hydrogen Fuel Initiative, that he looked forward to working with you on a successful effort on the ITER project.

Question. Is the Administration prepared to request the increased budgets in future years to meet this large commitment without negatively impacting other Science programs?

Answer. The Administration will continue to request budgets that honor our commitment to the ITER project while maintaining a strong research program across the Office of Science.

Question. Since ITER represents only one of several promising fusion research directions, will the Department continue to fund alternatives to the "tokamak" path towards fusion that is the focus for ITER?

Answer. Yes, the Secretary restated his commitment to a robust domestic program as he announced the President's decision to join the ITER negotiations. Part of that robustness is the continuation of our program in innovative confinement concepts as we strive to prepare for the most attractive energy embodiment of fusion in the future.

ADVANCED COMPUTING

Question. Last year, Japan raced ahead of the United States in the high-performance computing wars when it completed the world's fastest computer—the 40 teraflop Earth Simulator. As you are aware, the Japanese Earth Simulator was based on vector architecture that the U.S. supercomputing industry had largely abandoned. What does the United States need to do to catch up?

Answer. As you may know, much of the U.S. computer industry takes exception to premise that we have lost leadership (broadly defined) in high-performance computing because of a single Earth Simulator. Nevertheless, I take your question as addressing leadership in the areas of computational science for which the Earth Simulator has been designed, such as climate change. To revitalize and/or ensure ongoing U.S. leadership in strategic areas of computational science, we need to initiate an aggressive R&D program based on a strategy to deliver world class supercomputers for scientific applications. The program must be coordinated with DOE-NNSA and other Federal agencies with high-performance computing missions, to leverage existing investments in high performance computing and to establish a single, inter-agency strategy for high-performance computing. We expect to participate in this endeavor by supporting academic researchers, national laboratory scientists and engineers in partnerships with the U.S. computer industry to tailor computer designs and to provide the software programming infrastructure needed to ensure maximum performance of codes on complex scientific systems. We need to establish a computing capability to solve key DOE civilian science mission problems that is at least a factor of 50 greater than the present.

Question. What kind of supercomputing platforms do you need for the types of problems you are challenged with in the Office of Science?

Answer. Our computational scientists need supercomputing platforms that are easy to use and are free of the bottlenecks that presently constrain the performance of their codes on scientific applications. Due to the breadth of the Office of Science research portfolio, we envision our high-performance computational needs will be met by a suite of super computer architectures and software programming environments. We expect this suite of architectures will consist of high-performance variations of scalar systems, vector architectures and approaches that are currently considered novel.

Question. How will you get them and how much will it cost?

Answer. We will foster the development of these systems by working with all interested U.S. vendors to influence future offerings to meet the needs of our computational scientists. Supercomputer platforms will be acquired based on a competitive evaluation and review of systems offered by vendors. Performance on actual scientific applications will be one of several review criteria. Before we are in a position to evaluate prospective systems, we need to embark on a long-term commitment of establishing research partnerships between application scientists, computer scientists and supercomputer designers.

Although we expect to take advantage of commercial market drivers whenever feasible, we do recognize that these supercomputing platforms are likely to be in the specialty category of vendor offerings. Therefore, it is conceivable that each supercomputer platform could cost several hundred million dollars. Future special purpose architectures targeting certain applications might be cheaper if the full suite of partnerships mentioned above were supported.

Question. Credible experts argue that we will need to spend an additional $500 million over what we have planned for the next 4 years in order to catch-up. Do you agree?

Answer. The Administration is still in the process of developing a government-wide strategy for high-end computational science, so it is premature to directly answer your question.

NANOSCALE RESEARCH

Question. In fiscal year 2003, the Congress added $4.5 million to begin construction of the Center for Integrated Nanotechnology in my home State of New Mexico. This year, I am pleased to see the Department request $30 million more for the construction of this $75 million facility. The Department is also proceeding with construction of four other centers around the country. I am concerned that the current Science baseline budget does not include sufficient research dollars to effectively utilize the five nanoscale centers that will be constructed over the next few years—requiring an additional $350 million over the next 3 years. Are we building too many centers, too fast, without planning for the resources to utilize them?

Answer. The five Nanoscale Science Research Centers that are under construction (one joint with the State of Illinois) as well as their subsequent operations funding which includes user support and research support are all accommodated within the Science baseline budget presented in the President's Budget Request. These Centers are a high priority for the Administration and the Department, because they offer unique capabilities and build on the investments in the major synchrotron radiation light sources and neutron scattering facilities that are already in place at the Department's laboratories.

GENOMES TO LIFE AND OTHER FUNDING SHORTFALLS

Question. The Department wants to grow the "Genomes to Life" program in a way that will realize the promises of the Human Genome Project, but that will require $850 million to build the necessary research facilities. In addition, you have expressed your desire to grow the Science Teacher Workforce Development program. Furthermore, we are always under pressure to provide additional money for better utilization of our existing science facilities. So, my questions to you are as follows. How do we find the resources to do all of these things? Or have we "bitten off more than we can chew"?

Answer. The President's budget request before the Congress represents a substantial step in allowing us to exploit the scientific opportunities before us. The programs that you mention are multi-year efforts, and we have to continue to prioritize and make tough choices in these times of constrained budgets. The completion of some projects, along with reduced funding requirements for the Spallation Neutron Source effectively provides a 5 percent increase in funding for science, allowing us to strengthen our research programs while also increasing operating times at our user facilities, and beginning a new pilot program at Argonne National Laboratory to train K–14 science and math teachers.

SCIENCE EDUCATION

Question. Dr. Orbach, I appreciate the emphasis in your testimony on a $1 million pilot program for improving the science and math qualifications of teachers in our K–14 educational system in answer to the President's call for "qualified teachers in the classrooms." As you know, such programs were conducted some years ago by the DOE. I know from many personal testimonies that these programs were highly successful in New Mexico. I really question whether you need any pilot program at all. My recommendation is that you simply restart the successful programs of a few years ago at levels far higher than $1 million. Would you be willing to provide an estimate of how large a program the Department could undertake in fiscal year 2004 in this vital area?

Answer. Our National laboratories have continued to support fellowship and internship opportunities through their education and workforce development offices. In most respects, these offices have dramatically improved in their quality assurance and efficiency. Our entire application, placement, tracking and evaluation system is online. The President's fiscal year 2004 request allows for a robust pilot program.

FUNDING OF SCIENCE PROGRAMS

Question. Dr. Orbach, fiscal year 2004 is the third year of basically flat budget requests for the Office of Science. I think the Department and Administration must start requesting significant increases in the budgets for the Office of Science. Since that office is the largest supporter of research in most physical sciences, I fear that we are seriously jeopardizing the competitiveness of our Nation by short-changing

developments in these areas. In fact, our rush to fund health sciences through the NIH, without comparable funding to the Office of Science, may prevent us from realizing our goals in the health sciences. After all, many developments in health sciences also require advances in the physical sciences, we need strong health and physical sciences to truly enable advances. Do you share my concern that we must do more to increase the Nation's talent pool in the physical sciences and that increased budgets for the Office of Science are critically important in future years?

Answer. Senator, before answering, let me thank you for your strong support for science and education. I do share your concern. I believe that we need to do whatever we can to encourage U.S. students to choose careers in mathematics, science and engineering. It is for that reason that our budget request proposes a pilot program for training of K–14 mathematics and science teachers. I would point out, however, that when a combination of reduced requirements for funding in one time programs and large construction projects are taken into account, funding for the Office of Science in the President's budget requests for fiscal year 2003 and fiscal year 2004 represented increases for science well above the rate of inflation.

Question. Do you believe the United States is in danger of losing its global competitive edge to the Japanese or the Germans or the French because the Federal Government has ignored basic research funding for the physical sciences?

Answer. A strong program of basic research in the physical sciences and a scientifically literate workforce are essential to the continued innovation that underpins our global competitiveness, and I believe that the President's budget request for science will fund a strong and balanced program of scientific research for the Nation.

LOW DOSE RADIATION RESEARCH

Question. I helped initiate your important program in low dose radiation research a few years ago, to try to better determine health risks from exposures to low levels of ionizing radiation. This research could have far-reaching implications, from improved cleanup standards for DOE sites to better appreciation of the risks associated with operations involving radioactive materials. With the National Academy's seventh study on Biological Effects of Ionizing Radiation (called BEIR VII) nearing a conclusion, results from this program are especially timely. In past years, this budget has been reduced in budget requests, only to be restored by Congress. I appreciate that this year the request of $17.5 million is close to the current year level of $17.8 million. But it's my understanding that the DOE's own program plan for this study calls for budgets of about $25 million. Is this work advancing the state of knowledge in this critical area at a pace to impact the BEIR VII study?

Answer. Yes, while the Low Dose Radiation Research program is effectively in its fourth year of funding and, as you correctly note, funding has always been at a level $4 to $8 million below that recommended by the Advisory Committee for the Biological and Environmental Research program, the low dose program is already having a substantial scientific impact. Building on decades of radiation biology research we can now study the biological effects of radiation with research approaches that are 10, 100, or even 1,000 times more sensitive than those previously used. Progress has been made in our ability to study lower, more realistic doses of radiation by a combination of knowledge from past research, from new, more sensitive technology, and from advances such as those provided by the Human Genome Project. Today, for the first time, scientists have actually been conducting research that overlaps or approaches the maximum allowable radiation doses above background for the public (100 mrem/year above background) or for nuclear workers (500 mrem/year above background). The BEIR VII committee bases their report on information received from expert scientific testimony and from peer reviewed scientific publication. To date, the Low Dose Radiation Research Program has resulted in over 190 new papers in the scientific literature. The director at the National Academies for BEIR VII is well aware of the Low Dose Radiation Research Program and has been given a list of publications resulting from the program. Thus, the BEIR VII will certainly consider the results of this research program in their deliberations.

Question. And is it resource constrained in its progress?

Answer. We believe that the original estimate made by the Biological and Environmental Research Advisory Committee for a 10-year, approximately $220 million research program, while unconstrained by the realities of tight budgets, is still a reasonable estimate to optimize progress through the normal, iterative process of scientific discovery. To date, including the current fiscal year (fiscal year 2003), the program has invested approximately $82 million in new low dose radiation research.

SCIENCE IN AN UNDERGROUND LABORATORY

Question. Last year there was a review by NSF to explore deep underground sites for sensitive nuclear experiments. As part of their review, there was strong recognition that some experiments require the deepest location—like the Homestake mine—and others benefit more from the ultra-low background, ultra-clean conditions, and superb infrastructure associated with the Waste Isolation Pilot Plant at Carlsbad. I provided funding within the EM budget this year to start a neutrino experiment at WIPP. But logically, these experiments should be championed within the Office of Science. Will the Office of Science seriously evaluate and champion opportunities for key experiments in the environment provided by WIPP?

Answer. The Office of Science endeavors to support the most interesting and promising experiments in all fields of basic research consistent with its mission. We are aware of scientific opportunities presented by a wide range of possible underground experiments, though we have not received any formal proposals for such experiments. We are also aware that there is an ongoing scientific debate about the technical criteria for an underground site that is dependent upon the needs the various experiments. Nevertheless, the Office of Science is keenly aware of the Waste Isolation Pilot Plant's (WIPP) mission to dispose of defense-related transuranic waste to protect human health and the environment. WIPP is a critical facility for the Office of Environmental Management's (EM) efforts to accelerate cleanup at sites across the DOE complex.

Last year, as ordered by Secretary Abraham, EM completed a top-to-bottom review of its cleanup program and concluded that significant change was required in how the Department attacked risk reduction and cleanup of its sites. A major finding of the review was the need to realign the EM program so its scope is consistent with an accelerated, risk-based cleanup and closure mission. The review team underscored the necessity that EM should redirect, streamline, or cease activities not appropriate for accelerated cleanup and closure.

Utilizing WIPP to conduct science experiments, no matter how meritorious, would represent a major commitment of EM financial and administrative resources for implementation and oversight of these activities, which would not be consistent with the Administration's accelerated cleanup initiative. A laser-like focus on EM's core mission is needed to realize the cleanup of the Cold War legacy in our lifetime.

GLOBAL CLIMATE CHANGE RESEARCH

Question. The Department of Energy has had a long-standing role in the Global Climate Change research agenda. The White House just recently announced a new Global Climate Change strategy. Can you describe for me the role that the Department of Energy will have in the new White House agenda and the need for enhanced research on Global Climate Change that would take advantage of the assets in DOE's laboratories?

Answer. The Department's role in the new White House agenda for climate change Research will focus on improving climate models by resolving major uncertainties in estimates of the sensitivity of the climate system to various factors such as clouds and aerosols. Climate change research supported by the Department will also help resolve the magnitude and location of the North American carbon sink, and provide improved methods and models for assessing the environmental and economic costs and benefits of climate change, and of different options and strategies for mitigating the change. Enhancements of Global Climate Change Research that would take advantage of assets at DOE laboratories include climate modeling and ecological processes. Enhanced climate modeling research would enable researchers to take greater advantage of computing facilities and computer science capabilities at DOE laboratories, and to allow climate and carbon cycle modelers at DOE laboratories to more fully utilize the data and information coming from other DOE climate change research programs such as the Atmospheric Radiation Measurement program and Ocean and Terrestrial Carbon Cycle Research programs to develop, test, and improve fully-coupled climate models. Enhancement of research on ecological processes would provide the opportunity to more fully utilize the unique interdisciplinary capabilities and facilities at DOE laboratories in molecular biology, ecological genomics, ecology, and computer modeling and simulation. The research would investigate how complex ecological systems respond to climate and atmospheric changes and how their capacity to, for example, sequester carbon from the atmosphere and adapt to or recover from potential adverse impacts of such changes can be enhanced.

SCIENCE LAB INFRASTRUCTURE

Question. Dr. Orbach, the Office of Science manages 10 science labs that represent a Federal investment of tens of billions of dollars in the most advanced scientific user facilities in the world. The annual budget process seems to rarely reward the prudent and responsible program manager who reinvests in infrastructure to maintain the facilities. Two years ago this Committee initiated a Facilities and Infrastructure program for the NNSA to reinvigorate the NNSA weapons complex and it is starting to make a significant difference. Dr. Orbach, do you believe the Science facilities that you oversee need a significant infrastructure reinvestment to revitalize the Science Labs research facilities and would you be willing to budget for such an initiative?

Answer. The Office of Science has identified over $1.5 billion of line item projects to renovate, modernize and replace existing buildings and support facilities at the SC laboratories to better support our research missions. A complete listing and description of the projects can be found at the SC web site: http://www.science.doe.gov/SC-80/sc-82 under "Infrastructure Needs Assessment." I am working with the laboratories to develop a strategy for funding infrastructure improvements.

FUTURE NUCLEAR ENERGY BUDGET REQUIREMENTS

Question. Mr. Magwood, as I indicated in my opening statement, I am generally encouraged with the progress in nuclear R&D. The Department now has in place the structure of a well-thought-out nuclear R&D program that addresses the near-term goal of bringing a new plant on line through the Nuclear Power 2010 program; while performing the R&D necessary for nuclear power to support the growing demand for electricity world-wide over the next 50 years through the Generation IV Program and the Advanced Fuel Cycles Initiative. All of these initiatives require funding well in excess of what is provided in the current baseline?

Answer. We are confident that the fiscal year 2004 budget request for these programs will meet the near-term needs of these programs, most of which are at the early stages of development. We will evaluate future funding needs as we more precisely define the areas of work and implement these initiatives. Clearly, significant resources would be needed to support the development, design, and deployment of innovative technologies to achieve the economic and energy security benefits of the programs. Whatever course our activities take, we expect the funding the Department requests to be highly leveraged with our international and U.S. industry partners.

Question. What level of resources will be required to achieve the stated goals of each of these initiatives over the next 10 years?

Answer. The Generation IV Nuclear Energy Systems Initiative is in an early stage of development. The highest priority Generation IV project is pursuing advanced nuclear technology that can produce both cost-effective hydrogen and very efficient electricity production. The out-year funding plan for Generation IV activities is currently being developed. Discussions with potential collaborating partners are underway and we anticipate substantial cost-sharing with both industry and the international community. The estimated costs for AFCI research and development over the next 10 years are presently under review by the Administration and have not been finalized.

Question. What is the Department's funding strategy?

Answer. The Department is in the early stages of implementing the Generation IV nuclear energy systems initiative and the Advanced Fuel Cycle Initiative. Regardless, the Department intends to leverage a modest Federal investment with collaboration with our international partners.

Question. What kind of resources can we reasonably expect from international or industry collaborators?

Answer. We are currently exploring cost-sharing arrangements for the design, licensing, construction, and startup of the Very-High-Temperature Reactor (VHTR) with potential domestic and international partners, both private and government. Substantial cost-sharing is expected. Over the past 3 years, the AFCI program has established two major international collaborative agreements which have provided over $100 million worth of analytical and experimental data to the program. One agreement is with the French Commissariat à l'Énergie Atomique, and the other agreement is with the Paul Sherrer Institute in Switzerland. Also, the Secretary of Energy recently signed an agreement with the European Commission, which provides for collaborative AFCI research and development with European countries.

NUCLEAR HYDROGEN INITIATIVE

Question. Hydrogen technologies will only allow us to free ourselves from dependence on foreign oil if we can economically produce it in a manner that does not harm the environment. Current methods of producing hydrogen based on fossil-fuels are far too costly. I am hopeful that one or more of the Generation IV reactor technologies would allow us to generate hydrogen on a scale that would support a future hydrogen based economy. I commend the Department for requesting $4 million specifically for the nuclear hydrogen initiative. What level of resources would the Department need to develop and demonstrate on a pilot scale a nuclear reactor for hydrogen production?

Answer. The Department's new Nuclear Hydrogen Initiative is designed to develop and demonstrate advanced technology hydrogen production systems using nuclear energy. The Department plans to achieve this goal by constructing progressively larger scale demonstrations using non-nuclear heat sources, designed and optimized to be eventually driven by heat from a high temperature nuclear system. The Department is also exploring partnerships with industry and the international community that could support a full-scale prototypical system to demonstrate the commercial scale production of hydrogen. With funds provided by Congress in fiscal year 2003, we are currently developing a hydrogen technology roadmap which will define the development program leading to a pilot scale experiment. The funding estimates for a pilot scale facility will be developed over the next several months.

Question. Can we do it on the time-scale of the President's broader hydrogen timeline of 2015 to 2020?

Answer. We believe nuclear-based production of hydrogen could be deployed on the time-scale of the President's 2015–2020 hydrogen timeline.

NUCLEAR POWER 2010 INITIATIVE

Question. Three years ago, this Subcommittee led the way in creating a new R&D program in Nuclear Energy Technologies. The effort has been focused on both near-term and longer-term development of next generation power reactors. There are great opportunities to deploy new reactors that would have superior economics, no possibility of a core-meltdown, reduced waste, and more proliferation resistant. I commend the Department for providing $35 million to support a near-term effort with the goal of having new advanced reactors operating in the United States by 2010. Can you elaborate on this program in greater detail and provide an update?

Answer. The Department believes it is in the Nation's interest to deploy new baseload nuclear generating capacity within the decade to achieve the National Energy Policy objectives of energy supply diversity and security while minimizing the impact on the environment. To enable the deployment and operation of new, advanced nuclear power plants in the United States by the end of the decade, it is essential to demonstrate the new, untested Nuclear Regulatory Commission (NRC) regulatory and licensing processes for the siting, construction, and operation of new plant designs. In addition, research and development on near-term advanced reactor concepts that offer enhancements to safety and economics is needed to enable these new technologies to come to market.

In fiscal year 2002, the Department initiated the Nuclear Power 2010 program. This program is a joint government and industry cost-shared effort to identify sites for new nuclear power plants, develop advanced nuclear plant technologies, and demonstrate new regulatory processes that support a private sector decision by 2005 to order new nuclear power plants for deployment in the United States within the decade.

As an initial step in the Nuclear Power 2010 program to demonstrate untested regulatory processes, the Department is cooperating with three power generation companies—Exelon, Entergy and Dominion Resources—to demonstrate the Early Site Permit (ESP) process at sites where these companies currently operate nuclear power plants (Clinton Nuclear Power Station, Grand Gulf Nuclear Power Station, and North Anna Nuclear Power Station, respectively). This regulatory process is intended to approve sites for the construction of new nuclear power plants in advance of a utility commitment and order for the nuclear plant. Within the scope of these 50/50 cost-shared industry cooperative projects, the three power generation companies will develop and submit formal ESP applications to the NRC by fall of 2003. NRC's approval of the then-submitted ESP applications is expected in early 2006.

In 2003, the Department plans to expand its cooperation with the nuclear industry by soliciting additional cooperative projects with power companies or consortia of power and industry companies that implement power company plans to deploy new nuclear plants. Cooperative projects would include activities to demonstrate the

combined Construction and Operating License (COL) process and develop a standardized advanced nuclear plant designs.

The Department has also initiated in fiscal year 2003 a cost-shared project with industry to assess the construction schedule, manpower, and cost requirements of the new advanced nuclear plant designs being considered by power companies for near-term deployment and to identify promising improvements in construction methods and techniques to shorten the construction durations for these next new nuclear power plants.

Question. Does the Department still plan on initiating a cost-shared project with a utility to demonstrate the "Construction and Operating License" process?

Answer. The Department believes that demonstration of the combined Construction and Operating License (COL) process is essential to achieve near-term deployment of advanced nuclear power plants in the United States. In fiscal year 2003, the Department plans to issue a solicitation to seek proposals from power companies or consortia of power and industry companies for projects that enable a new nuclear power plant to be ordered and licensed for deployment in the United States within the decade. This project will provide for design completion of a standardized advanced reactor plant, preparation and submission of a COL application and support of NRC review, and hearings associated with the application.

Question. What recommendations can you provide to this committee as to how the government can address the financial and business risk associated with building and licensing new nuclear plants?

Answer. There are currently three ways that an electric generating company could finance a new nuclear plant: by obtaining commercial debt financing, through equity financing, or a combination of both. These options are not currently attractive because of significant financial barriers and risks associated with building the first few new nuclear plants. Last year, Sculley Capital, an independent financial advisory firm, conducted a study for DOE of barriers to new nuclear plant deployments and identified a range of financial assistance mechanisms that could address the financial risks associated with building the first few new nuclear plants. The study concludes that substantial cost improvements in the cost per kilowatt-hour would be realized following deployment of the first few plants, thereby allowing future builds to be fully competitive in the electricity marketplace. This study has sparked an ongoing discussion both inside the government and in the private sector, but no conclusions have yet been reached in either.

NASA'S NUCLEAR SYSTEMS INITIATIVE

Question. The fiscal year 2003 NASA budget proposed a "nuclear systems initiative" to develop new radioisotope power systems for on-board electric power on future space platforms. It would also conduct research and development on nuclear electric propulsion systems that would allow future space craft to speed throughout the outer reaches of the solar system. NASA has proposed spending up to $1 billion in the next 5 years. What has transpired over the last year?

Answer. A significant amount of planning and coordination between NASA and the DOE has taken place in preparation for NASA's Nuclear Systems Initiative, now named "Project Prometheus." Activities conducted under existing programs at DOE were focused to help prepare for the initiation of the effort. For example, with regards to the radioisotope power systems, a DOE contract was awarded to Lockheed Martin Astronautics for a Stirling Radioisotope Generator, and industry proposals for a Multi-Mission Radioisotope Thermoelectric Generator are now being evaluated by the Department. Also, the purchase of 1 kilogram of Pu-238 from Russia is underway.

With regard to the nuclear electric propulsion part of Project Prometheus, NASA Research Announcements (NRA's) were issued for power conversion and electric propulsion technology contracts. Initial space reactor power system screening activities were completed using an integrated team of specialists from DOE laboratories and NASA centers to assess combinations of reactor and power conversion technologies and a briefing on these screening activities was provided to industry. DOE labs have also supported definition of three reactor concepts for future consideration. A draft RFP was also developed by NASA with support from DOE for mission and technology trade studies associated with a Jupiter Icy Moons Orbiter Mission (JIMO) in order to prepare for possible future industry engagement.

These activities have helped to prepare for initiation of a coordinated effort between NASA and DOE as Project Prometheus now commences its first year.

Question. What role will be DOE's role in this exciting new effort?

Answer. DOE will continue as the executing agent for the development of Radioisotope Power Systems. These efforts will include the Stirling Radioisotope Gener-

ator (SRG), the Multi-Mission Radioisotope Thermoelectric Generator (MMRTG), the performance of safety analyses, and the procurement of additional Plutonium-238 as needed in support of the radioisotope program and potential future missions. For the development of space fission reactor technology, or the nuclear electric propulsion part of Project Prometheus, NASA and DOE are currently examining the best approach for management of the development effort within the Department. These reviews are ongoing and include consideration of possible participation by DOE's Offices Nuclear Energy, Science and Technology and Naval Reactors.

ADVANCED NUCLEAR MEDICINE INITIATIVE

Question. The Advanced Nuclear Medicine Initiative (ANMI) provides basic research and educational grants in the field of nuclear medicine. These R&D grants have yielded exciting results for the development of new radiopharmaceuticals, insights in radiobiology, and possible new methods of treating cancer. In recent years, the program has been funded at the level of $2.5 million per year. In fiscal year 2003, funding was dropped to zero. The Department has also proposed changing the manner in which it provides radioisotopes to the research community. The Department proposed this on the theory that it could reach agreement with other sources (most likely NIH) to support this important mission. Has the Department secured such an agreement? If not, what are the prospects?

Answer. Department of Energy officials are at the beginning stages of discussion with officials of the Department of Health and Human Services, including the National Institutes of Health on the subject of obtaining support from NIH for production of isotopes associated with medical research sponsored by NIH. There is broad support for medical research in development of new radiopharmaceuticals both within the government and the private sector, and we are confident that as the benefit for this research is demonstrated that there will be increased support for offsetting the costs associated with the production of medical research isotopes.

Question. Would you comment on the record how a DOE sponsored revolving fund might be used to support this mission?

Answer. As was done with the Advanced Nuclear Medicine Initiative in fiscal year 2000, the revolving fund could be a suitable vehicle for supporting medical isotope research, including production of isotopes for such research.

ADVANCED FUEL CYCLE INITIATIVE

Question. I commend the Department for supporting the Advanced Fuel Cycle work that this committee has strongly supported over the last few years. Will you describe for the committee some of the successes of the AFCI program, its relationship to the Generation IV reactor program, and what your expectations are for the next few years?

Answer. The goals of the Advance Fuel Cycle Initiative are to develop fuels and fuel cycle technologies required for the Generation IV Nuclear Energy Systems Initiative and to develop advanced spent fuel treatment and transmutation fuel technologies to optimize the performance of the Yucca Mountain repository and delay or eliminate the technical need for a second repository.

In fiscal year 2002, the program had several important accomplishments. In the area of spent fuel treatment, the Department developed UREX+ technology and successfully demonstrated the separation of uranium from commercial spent fuel at a purity level of over 99.99 percent, which is equivalent to low-level Class C waste. Since spent fuel is made up of 95.6 percent uranium, this is clearly a major demonstration of the potential for reducing the volume of spent fuel destined for a geologic repository. Other major successes include the development and manufacture of advanced non-fertile fuels (i.e., fuel which does not produce plutonium during the fission process). Both nitride and metal advanced non-fertile fuels have been manufactured and have passed quality assurance standards necessary to qualify for irradiation testing in the Advanced Test Reactor. This activity directly supports Generation IV fast-spectrum reactor fuel development.

As described in the AFCI Report to Congress, issued in January 2003, the AFCI program is pursuing parallel paths, AFCI Series One and AFCI Series Two, to develop technologies both in support of the Generation IV program and spent fuel treatment and transmutation. AFCI Series One technology development is an intermediate term activity which is focused on the developing advanced spent fuel treatment technologies. Specifically, this technology separates various isotopic components from commercial spent nuclear fuel, including the extraction of uranium at a purity of greater than 99.99 percent for potential reuse, or storage as low-level waste. In addition, the program is developing proliferation-resistant fuel that can be recycled in existing light water reactors to extract energy and reduce the pluto-

nium inventory in the spent fuel. In fiscal year 2003, AFCI plans to demonstrate the separation of a plutonium-neptunium and cesium-strontium on a laboratory scale. The successful demonstration of cesium-strontium, at a high purity, can provide a unique advantage to the repository program because it will allow the repository to be operated in a cold condition, by isolating all the short-term heat long in one drift, or above ground. The program is also in the process of fabricating several specimens of oxide fuels containing various combinations of uranium, plutonium, and neptunium for potential use in existing light water reactors as a means extending the energy resource of spent fuel and to reduce the inventories of plutonium. These advanced oxide fuels are planned for irradiation testing in the Advanced Test Reactor (ATR) in fiscal year 2004.

AFCI Series Two technology development is a longer term activity (2020–2030 time frame). The main focus of AFCI Series Two is to develop advanced, non-aqueous technologies which are cost effective, environmentally sound, and capable of handling large volumes of fast reactor spent fuel. AFCI Series Two technology development also includes the development of advanced fuels for fast spectrum reactors—Generation IV reactors including the capability of these reactors for handling the transmutation mission. Application of AFCI Series Two transmutation technology can significantly reduce the long-term radiotoxicity and long-term heat load in the geologic repository.

The research and development being conducted in the AFCI program is focused on producing results that will provide decision makers sufficient information on cost, schedule, and waste streams to inform decisions in fiscal year 2007 regarding the need for a second repository.

CUTS TO NERI AND NEPO

Question. Mr. Magwood, I appreciate the significant increase in budgets requested for Nuclear Energy. But I'm surprised that a program like the Nuclear Energy Research Initiative or NERI, that is the largest supporter of university-based research in this vital field, is targeted for a cut of 50 percent. I am also concerned that the Nuclear Energy Plant Optimization or NEPO program is targeted for no funding, when the Nation depends strongly on our existing nuclear plants to avoid having to replace them with more polluting alternatives. Can you please discuss the rationale for halving the NERI budget and killing the NEPO budget just when we are undertaking other important ventures to secure a future for nuclear energy in the Nation?

Answer. First, I think it is important to make clear that we believe both the Nuclear Energy Research Initiative (NERI) and the Nuclear Energy Plant Optimization (NEPO) program are important and very successful programs. The programs have attracted significant international and private sector co-funding. Moreover, the important initiatives that we believe will form the base for our nuclear energy research program in the future—the Nuclear Hydrogen Initiative, the Generation IV nuclear energy systems initiative, the Advanced Fuel Cycle Initiative—all grew out of the success of innovative NERI research and development.

While the funds requested for NERI in fiscal year 2004 represent a reduction from previous years, the budget request will allow us to support those projects that are continuing in the NERI and International NERI programs. During the coming year, we will refine and detail our plans for the Nuclear Hydrogen Initiative, Generation IV, and the Advanced Fuel Cycle Initiative. Once this is done, the Department will be in a position to evaluate NERI in fiscal year 2005 in the context of our entire research portfolio.

Regarding the NEPO program, we have successfully leveraged a small Federal investment with industry to address technical issues associated with the long-term operation of the Nation's existing 103 operating nuclear power plants. The program has funded a total of 33 projects during its first 3 years, addressing issues such as plant aging and electrical generation optimization. Thus, it is our hope that industry, who invests between $80 and $90 million dollars annually on research, will choose to continue some of these projects.

UNIVERSITY REACTOR FUEL ASSISTANCE AND SUPPORT

Question. For the current year, the Congress provided $18.5 million for the University Reactor support program. Can you give me an update on this effort?

Answer. All current university programs efforts will be continued, including providing fuel to university research and training reactors, assisting university reactors to share their reactors with other universities and secondary schools for educational and training purposes, improving equipment and instrumentation at university re-

actors, and providing research grants to university nuclear engineering departments.

The Department continues to award numerous fellowships and scholarships to students pursuing a nuclear engineering or a health physics degree and assisting students at minority universities to achieve a degree in nuclear engineering by partnering with a majority nuclear engineering institution; helping to reinvigorate the radiochemistry educational program through assistance to graduates, post-doctorates, and faculty; and conducting outreach to college freshman and secondary school students and teachers through the American Nuclear Society by providing teacher workshops in the basics of nuclear energy and engineering.

Lastly, the Innovations in Nuclear Infrastructure and Education (INIE) initiative continues to maintain the Nation's university research reactor infrastructure by awarding the fifth INIE grant. The INIE program focus is to help strengthen the nuclear engineering infrastructure which is vital to producing the nuclear engineers the Nation requires for operation of its nuclear facilities, national laboratories, and universities.

Question. Will this budget request allow the Department to expand its support to the regional reactor consortiums?

Answer. The fiscal year 2004 budget request will enable the Department to continue support for five regional reactor consortiums. Four awards were made in fiscal year 2002, with the additional funds appropriated in fiscal year 2003; one additional award will be made. Two additional consortia have been selected for future award.

URANIUM-233

Question. The Congress has urged the Department to proceed with a Request for Proposal on a project to extract medically valuable isotopes from the excess uranium-233 stored at Oak Ridge National Laboratory. This is potentially a very exciting effort. Can you provide an update on this effort and tell when you expect the RFP will be out?

Answer. The Department's project to treat its inventory of U233 will greatly reduce the high cost associated with the storage of this material and demonstrate the Nation's leadership in the effective and responsible management of fissile materials. Perhaps more importantly, this project will provide researchers all over the country with ready access to isotopes that have shown considerable promise in treatment of various forms of cancer.

The RFP was issued on June 13, 2002, and proposals were received on September 26, 2002. On February 14, 2003, the Department notified the bidders that were found to be in the competitive range required for the contract that their proposals would be evaluated for final selection. The evaluation process continues and we anticipate an award this summer.

LES

Question. Mr. Magwood, the Department has previously commented on the need for new domestic enrichment capacity as a means of maintaining a reliable and economical U.S. enrichment industry. One of the ventures to accomplish this is led by the European consortium Urenco, a company with proven centrifuge technology. I know you are quite familiar with the company and their technology. Do you have any concern on your part that the efforts of Urenco to build a new facility in the United States would in any way pose a national security concern?

Answer. The Administration places a high priority on ensuring nuclear nonproliferation safeguards are in place and that access to sensitive technology is controlled. The information available to the Department indicates that URENCO has acted responsibly with regard to the control of sensitive technology and the employment of non-proliferation safeguards.

The Department of Energy believes that LES's plans for the deployment of centrifuge technology in the United States are of considerable national benefit. Deployment of an LES plant will help assure the important energy security objective of maintaining a reliable and economical U.S. uranium enrichment industry.

Question. Do you believe that the development of new enrichment capacity is sufficiently important to U.S. energy security objectives that the development of a domestic facility by Urenco should therefore be encouraged and facilitated in some manner by DOE? If so, how?

Answer. The Department believes there is sufficient domestic demand to support multiple commercial uranium enrichment plant operators in the United States and that competition is important to maintain a viable, competitive domestic uranium enrichment industry for the foreseeable future. The U.S. Government has encouraged the three Allied government partners in Urenco (Great Britain, the Nether-

lands and Germany) to continue its plans to deploy a new commercial uranium enrichment plant in the United States.

COST OF DEPLETED TAILS DISPOSAL

Question. Pursuant to section 3113 of the 1996 USEC Privatization Act, DOE is obligated to accept depleted tails for disposal from domestic commercial enrichers, if the tails are declared low-level waste, and subject to the generator paying the cost of disposal. DOE has already agreed to accept post-privatization tails from USEC for disposal. Is this same option available for the depleted tails of any other commercial enrichment facility operating in the United States?

Answer. The NRC has not characterized depleted uranium tails as low-level radioactive waste; therefore, Section 3113 of the Privatization Act does not obligate the Department to accept commercially generated depleted uranium tails for disposal. The Department agrees with the NRC, and would not support an initiative to declare depleted uranium tails as low-level radioactive waste. Nevertheless, in view of the Department's plan to build DUF6 disposition facilities and the critical importance the Department places on maintaining a viable domestic uranium enrichment industry, the Department acknowledges that Section 3113 may constitute a "plausible strategy" for the disposal of DUF6 from the private sector domestic uranium enrichment plant license applicants and operators.

The Department has two agreements to accept depleted uranium generated by USEC. In the first case, the government received $50 million to accept 16,674 metric tons of depleted uranium generated by USEC during the privatization process. The second case is the June 2002 agreement between USEC and DOE. While DOE agreed to accept title (but not custody until the Department is ready to disposition) to 23,300 metric tons of depleted uranium hexafluoride as part of the agreement's consideration, USEC agreed to a range of important actions, including commitments to operate Paducah gaseous diffusion plant until replaced and to deploy advanced enrichment technology employing DOE technology.

Question. Would one or both of the two conversion facilities under construction be available on the same terms and conditions to any other commercial enricher?

Answer. No authority, procedures, or cost for such a service has been established. Were a commercial enricher to request such a service, the Department would give the request its full consideration.

Question. What do you project to be the per kilogram cost of accepting for processing and ultimate disposal depleted tails from commercial generators?

Answer. I note that Section 3113(3) of the USEC Privatization Act provides for reimbursement in an "amount equal to the Secretary's cost, including a pro rata share of any capital costs." As full costs of providing such a service have not been established, and the procedures to implement a service of processing DUF6 for ultimate disposition have not been created, it is not possible to project a meaningful cost estimate at this time. However, should a commercial company request such a service, the Department would fully consider its request.

Question. What is the per kilogram cost for the processing and disposal of the commercial tails that DOE has agreed to accept to date?

Answer. The actual marginal cost of processing and disposal of the depleted uranium hexafluoride generated by USEC has not been determined. Once the Department's conversion facilities have been built and are operational, a reasonable estimation of the marginal cost to process commercial tails can be calculated. These tails will be converted and dispositioned as part of the Department's inventories. It is expected to take 25 years to completely disposition the Department's depleted uranium stockpile. It should be noted that USEC will maintain custody of the tails the Department has agreed to accept under last year's Memorandum of Agreement until such time that they are accepted for processing.

HYDROGEN

Question. Mr. Garman, the grand promise in the President's vision of a hydrogen economy is dependent upon us finding a way to produce hydrogen economically and cleanly. Today, the primary method for hydrogen production is methane reformation, which results in significant releases of greenhouse gases. Options for future production will be built around either high temperature chemical processes, or high-temperature electrolysis. I know you are also looking to reduce the cost of producing hydrogen from renewable energy technologies. But, as I look at the issue, I am once again forced to the conclusion that nuclear power remains the most likely technology that will allow us to produce hydrogen in large quantities, economically and cleanly. What renewable technologies are most promising for the production of hydrogen?

Answer. As part of the Hydrogen Fuel Initiative, research underway in renewable hydrogen production technologies includes gasification and pyrolysis of biomass from forest, crop, and urban residues. Wind-powered electrolysis is another high potential pathway being researched, recognizing that 40 million tons of hydrogen per year (about half the U.S. light duty fleet energy requirement) could be produced using the wind resources of North Dakota alone, based on calculations by scientists at the lab. Water splitting through photolysis is being researched as well as solar-concentrated high temperature water splitting chemical cycles. Many of the aspects of solar-concentrated high temperature water splitting chemical cycles would be similar to methods using high temperature nuclear.

Finally, while hydrogen production from methane reformation (without sequestration) would result in carbon releases to the atmosphere, fuel cell vehicles using compressed hydrogen produced from natural gas would still use 50 percent less energy and emit 60 percent less carbon dioxide on a "well-to-wheels" basis compared to a gasoline-powered vehicle.

Question. How do they compare and contrast to the nuclear option?

Answer. Producing hydrogen from renewable energy sources or using the nuclear option can both potentially eliminate associated greenhouse gases. Nuclear-enabled high temperature chemical cycle water splitting is a promising route to hydrogen production with near-zero greenhouse gas emissions. This approach relies on the success of the next generation nuclear energy technology, i.e., Generation IV (GenIV). The GenIV nuclear reactor, would be the heat source for the high temperature cycle needed to produce hydrogen. This technology will require large central facilities and a hydrogen distribution network.

National energy security is assured through energy diversity. The renewable energy options being researched can support energy security through a diversity of feedstocks and processes. Renewable technologies such as biomass gasification or pyrolysis, ethanol reforming, wind powered electrolysis, and photo-electrochemial water splitting potentially offer the ability to provide distributed production at the point of use without an extensive hydrogen delivery infrastructure. In addition, renewable technologies such as high temperature chemical cycles using solar collectors as the energy source can help leverage the research being performed to develop the Generation IV nuclear technology.

BIOMASS R&D

Question. Mr. Garman, I note the 21 percent reduction the Department has proposed for biomass R&D. Among the renewable technologies under your purview, only biomass and hydrogen offer great promise in helping the country to wean itself off our dependence of foreign oil. As gasoline prices are projected to peak well in excess of $2 per gallon this spring, I find it odd that biomass took such a large hit. Can you explain your rationale?

Answer. The Department recognizes the tremendous potential of a well-focused biomass R&D program to develop biorefinery technologies that can produce fuels, power, and high-value chemicals and other products. Nevertheless, Congressionally-directed activities reduced the coherence of this program and significantly constrained the ability of our scientists and engineers to move these important technologies forward. Thus, when we made the tough choices about funding the most important research for our Nation's energy security, environmental, and economic goals, we decided to shift funds from the biomass program where the effectiveness of our R&D work was already reduced into other areas, particularly our longer-term hydrogen and fuel cell R&D.

EERE's budget reflects numerous factors: Administration priorities, efficiencies realized by combining all biomass research under one program, alignment with the Administration's R&D investment criteria, program performance, expected public benefits, and bringing to completion research on some technology applications that are ready to be commercialized. It is also important to recognize that in fiscal year 2004, DOE will continue collaborating with USDA in order to leverage both agencies' resources as we are doing in fiscal year 2003. In fiscal year 2003, under a joint solicitation required by the Biomass R&D Act of 2000, USDA will award $14 million and DOE $5 million for cost-shared R&D work identified in the Act.

Question. I also understand government-wide investment in biomass technologies is increasing in other departments, particularly USDA. But I do not believe Energy should cede its leadership role in technology development to another agency. Will you elaborate on the government-wide effort and Energy's role in that?

Answer. In fiscal year 2003, under a joint solicitation required by the Biomass R&D Act of 2000, USDA will award $14 million and DOE $5 million for cost-shared R&D work identified in the Act. USDA's focus is on environmental performance, eco-

nomic viability, and feedstock production. DOE's focus is on faster and cheaper conversion of biomass to fuels and other bio-based products, and on syngas clean-up and conditioning. DOE plays a lead role in seeking to reduce the production costs of sugars and syngas (sugars platform and syngas platform), intermediates needed in the production of several chemicals and fuels. In addition, DOE funds R&D on conversion processes for producing fuels, materials and chemicals that will leverage the two platforms.

HIGH TEMPERATURE SUPERCONDUCTIVITY CENTER

Question. Mr. Garman, I note that funding requests for Electric Reliability and High Temperature Superconductivity remain flat between fiscal year 2003 and fiscal year 2004. That surprises me a little, given the importance to the Nation of maintaining and improving reliability of our electricity supplies, and the potential immense impact that high temperature superconductivity can make to increase efficiency of many electrical processes. Are you confident that we are doing as much as we can do to improve our electric reliability and to utilize high temperature conductors as quickly as possible?

Answer. Yes, I am confident that we are doing as much as we should do. I agree that maintaining and improving the reliability of our electric supplies is a priority. The Electricity Reliability budget was increased by $360,000 in the fiscal year 2004 request, to $76.9 million. Within this budget, High Temperature Superconductivity R&D is $47.8 million, the same as our fiscal year 2003 request and $15.5 million (+48 percent) above the fiscal year 2002 level. We have also increased our fiscal year 2004 request for Transmission Reliability R&D by $3.0 million. The Department reduced its request for the Energy Storage program by $2.6 million, as mature technologies such as battery storage system are handed off to industry for commercialization, and as synergies with the transportation battery program are realized. In addition, the Department supports development of distributed energy technologies located closer to the point of end use, thereby increasing the chance that the electricity grid will stay in balance.

Question. Please provide an update of this effort and describe the types of commercial possibilities exist?

Answer. The Department recognizes the broad potential benefits of superconductivity in our future electrical system. The fiscal year 2004 request will support development of pre-commercial prototypes for 100-megawatt generators, longer distance power cables, fault current limiters, and larger-scale flywheel electricity systems. Also, the "next generation" of superconducting wire is expected to accomplish performance milestones needed for fiscal year 2005 use in equipment—a breakthrough for improving performance and reducing cost. Successful equipment research and development completion and availability of "second generation" wire will lead to commercial opportunities for advanced, cost-effective, power equipment that generally is half the size of conventional alternatives and has only half the energy losses. In addition, commercial possibilities also exist in defense applications of these technologies.

We note that the Department's budget for electricity reliability and high temperature superconductivity has grown by more that 50 percent since fiscal year 2001. We believe we can reach the end of the current research agenda by 2010, if we are able to focus our funding on achieving the goals and avoid directed projects that do not contribute to the goals.

Question. In order to achieve commercial successes, what level of investment should be made in R&D over what period of time?

Answer. The current level of funding is appropriate to bring about continual research advances, while still following a well-conceived research roadmap. Program successes include establishing world leadership in processing of "first generation" High Temperature Superconductivity wire as well as in development of advanced power equipment prototypes using this wire. Another success is the discovery at DOE laboratories of methods to make "second generation" superconducting wire, able to achieve program cost and performance goals, which are based on advancing the technology to the point where commercial success is possible. We believe we can reach the end of the current research agenda by 2010, if we are able to focus our funding on achieving the goals and avoid directed projects that do not contribute to the goals.

DEMONSTRATION PROJECTS

Question. Mr. Garman, the Department did not propose to continue funding for a number of demonstration projects that have been initiated over the last several years. I understand you are attempting to get more from your R&D dollars, and you

are not interested in duplicative demonstrations or funding projects that should properly be financed by the private sector. At the same time, this committee is well aware of unique cases where it is preferable to use appropriated dollars to demonstrate technologies before they become commercially attractive. Given these considerations, what criteria would you suggest to this subcommittee in evaluating the many requests for demonstration projects from Senators?

Answer. As you point out, there are unique cases in which it is appropriate to demonstrate technologies before they become commercially attractive. We strive to use the Administration's R&D investment criteria to guide all of our activities, including demonstrations. One criterion useful for evaluating demonstration proposals is the existence of significant market barriers to commercialization. These market barriers are conditions that do not satisfy the needs of a fully competitive market. Such a determination can only be made on a case-by-case basis, depending upon the market the technology faces. If the analysis indicates that we can reduce the market barriers, or validate the technology, we may propose a demonstration. Conversely, if we cannot show that there are market barriers forcing underinvestment by industry, we will not pursue the demonstration.

QUESTIONS SUBMITTED BY SENATOR THAD COCHRAN

DIAGNOSTIC AND INSTRUMENTATION LABORATORY (DIAL)

Question. Mr. Chairman, I'd like to thank the Undersecretary and Directors for testifying before this committee today. The work you do is very important to my State and to me. I'd like to commend David Garman, the Director of the Office of Energy Efficiency and Renewable Energy, for the work he does with biomass research.

This scientific research is so important to a rural, agricultural State like Mississippi. Biomass energy is estimated to contribute over 7 percent of Mississippi's total energy consumption—that amount is double the national average. The majority of our lumber facilities burn wood waste to generate steam for industrial processes. Biomass offers special opportunities for benefiting Mississippi's economy by keeping energy dollars in our State and by providing jobs in rural areas where biomass is produced. By using their wastes for energy, disposal costs are avoided, and industries are better able to compete.

The principal biomass waste streams that occur in Mississippi are generated by agriculture (e.g., cotton gin waste), wood products manufacturing (e.g., sawdust and wood scraps), animal wastes from confined feeding operations, and municipal solid waste collections (e.g., paper and cardboard, demolition waste, lawn and tree trimmings).

Last year, I visited a biomass plant in Winona, Mississippi and inquired about plans for using Federal funds that were appropriated in the fiscal year 2003 omnibus bill. I learned that the Winona biomass project can enter its final stages of discovering the organism which will cause the heated biomass to turn into gas. Once that organism or "bug" is discovered, the plant can operate from start to finish where chips of wood can be input, burned and then gasified into ethanol. In a town like Winona, that sort of success has great economic development potential.

I am pleased to learn that the Department is concentrating its biomass research efforts on the catalysts needed for biomass gasifiers. Many communities, beyond the scientific community, will benefit from this work.

I would also like to commend the Mississippi Diagnostic Instrumentation and Analysis Laboratory at Mississippi State University. I am pleased to see that you're funding good science, like the joint Los Alamos-Mississippi State project that we hope will be useful for both DOE and Homeland Security. A continuing concern is how do we take this magnificent science and turn it into the new technologies DOE needs to accelerate cleanup. I am hopeful that you consider using organizations such as DIAL at Mississippi State to turn your science into technologies that will be used at the DOE sites. Mr. Chairman, with your permission I have a question I'd like to submit for the record.

I am pleased to see that you're funding good science, like the joint Los Alamos-Mississippi State project that we hope will be useful for both DOE and Homeland Security. A continuing concern however is how do we take this magnificent science and turn it into the new technologies DOE needs to accelerate cleanup? Have you considered using organizations such as DIAL at Mississippi State to help bridge the "valley of death" to turn your science into technologies that will be used at the DOE sites?

Answer. The "valley of death" issue is a major concern of ours and we have been developing strategies to efficiently transfer scientific results to cleanup applications. First, we will work directly with site cleanup personnel to identify problem areas where science can make a significant impact and to further collaborate with the site on these specific issues. This will ensure that our scientific results are directly transferred to the sites for further development. We regularly conduct technical exchange workshops and find these invaluable, and will expand these at major cleanup sites. In addition, we have found that frequently, scientists want to take their work to the next stage themselves or at least provide technical support throughout the development. We encourage appropriate Environmental Management Science program researchers to develop partnerships with applied organizations, such as DIAL.

Question. What future plans do you have to work with DIAL?

Answer. The Environmental Management Science program will continue to select projects through competitive peer review that focus on the Department's cleanup problems. A key research area continues to be techniques to characterize and monitor contaminated sites. In partnership with the national laboratories and universities, DIAL is likely to be competitive in this area.

QUESTIONS SUBMITTED BY SENATOR HARRY REID

SCIENCE

Question. In the fiscal year 2003 Conference Report, we instructed you to reprogram funds, if necessary, to respond to the challenge of the Japanese Earth Simulator Computer. I believe the Earth Simulator is a warning shot across the bow for American computing companies and research. Does your advanced computing strategy adequately address the need for a robust investment in American supercomputing to maintain American competitiveness?

Answer. The fiscal year 2004 budget request for Advanced Scientific Computing Research includes $14 million for research in next generation computer architectures (NGA) for scientific simulation. The NGA allows us to embark on an R&D investment strategy to provide future high performance computing resources that are optimized for scientific simulations in areas of strategic importance to the Department.

Question. Given the remarkable successes of the Human Genome Project, can you help the Committee understand the new science drivers behind the Genomes to Life program?

Answer. The Human Genome Project, and DOE's associated Microbial Genome Program, determined a representative human DNA sequence and the DNA sequences of a rapidly growing number of microbes (nearly 100), most with direct relevance to DOE mission needs in energy and the environment. While the availability of genomic DNA sequence information has revolutionized the way scientists think about and do biology it is only a first of what will certainly be many very large steps. An organism's DNA sequence is the blueprint, the complete set of genetic instructions, which biology uses to create a living, working organism. It gives scientists a complete list of all the parts (proteins for example) along with the genetic on/off switches and rheostats that the organism uses to make sure that all of its genes are active only at the right time and place. However, the DNA sequence doesn't tell us what all those parts do, how they actually work, how they interact with each other, how they are regulated, and how different organisms, microbes in the case of the Genomes to Life program, interact with each other. These uncertainties are the scientific drivers for the Genomes to Life program. In the end, we want to understand microbes of interest to DOE so well that we have computational models that accurately predict their behavior in response, for example, to environmental contaminants, elevated atmospheric carbon dioxide. With this understanding we can use those microbes to develop biology-based solutions to DOE needs—abundant sources of clean energy, new solutions for cleaning up DOE waste sites, removal of excess carbon dioxide from the atmosphere.

Question. We have a large capital investment in the Office of Science user facilities that serve many users at universities and laboratories. Are we operating these facilities at maximum capacity in the fiscal year 2004 budget to meet the needs of these scientists?

Answer. The science user facilities are operating in the fiscal year 2004 request between 83 and 100 percent of maximum capacity. It is always difficult to find the right balance among completing priorities for facility operations, research, construc-

tion, etc. We are satisfied that we have allocated the funding in the request to achieve the best balance possible.

Question. As I mentioned in my opening statement, I am pleased that the United States has resumed its participation in the ITER project. However, the dollar levels look very low for our first year participation. Are the funds in the budget adequate to fulfill our international requirements?

Answer. The proposed fiscal year 2004 participation is of a preparatory nature, 2 years in advance of the start of construction, planned for fiscal year 2006. In this sense, the $12 million request is sufficient to begin our involvement.

Question. As a follow-up, the U.S. participation seems fairly modest compared to that of several of the international partners. Are you satisfied that it appears that the United States will be just a junior partner in ITER? Is a larger role something we should aspire to?

Answer. As just noted, the proposed fiscal year 2004 level of funding does not necessarily presage the level of U.S. participation during construction. With regard to that participation, the Administration wishes to make a significant contribution to this project. The ultimate answer to your question of participation levels will depend on the final number of interested parties, and I will note that South Korea has recently expressed interest in joining the negotiations.

Question. Are you having any problems attracting top flight scientists to your labs given the deteriorating condition of many of these facilities? If so, what can Congress do to address the situation?

Answer. Recruitment of new staff is particularly critical at this time as the generation that helped build the labs retires and the labs compete in the job market to replace them. While it is always difficult in hot new areas like genomics and nanoscience, decaying facilities and sites, lack of adequate housing for post-doc and graduate students, and salary gaps are making recruitment even more difficult. I should add that retaining the current staff is not easy either.

We have anecdotal comments from Lawrence Berkeley, Brookhaven and Oak Ridge National Laboratories that scientists are, in fact, declining job offers based on the condition of working space offered them. Their concerns range from quality of facilities and equipment and appearance to location and amenities.

Berkeley, Brookhaven and Oak Ridge are our oldest laboratories. Overall, 24 percent of the building space at our laboratories is more than 50 years old. We have identified over $1.5 billion, $1.2 billion of this total is for buildings, of line item projects to renovate, modernize and replace our existing buildings to better support our research missions. A complete listing and description of the projects can be found at the SC web site: http://www.science.doe.gov/SC-80/sc-82 under "Infrastructure Needs Assessment." We appreciate the support from Congress of the President's funding requests to modernize the Science laboratories.

Question. A few years ago you office supported an education program. I see that your fiscal year 2004 budget proposes a new workforce development program. Does this program address the workforce development needs of the scientific community?

Answer. Our approach to science workforce development is to have a comprehensive plan to expand the pipeline of students interested in, attracted to, and retained into science and technology careers. To do so, we have a major effort in offering mentor-intensive internships to undergraduate students at our national laboratories drawn not only from the typical 4-year research institutions but also from non-research institutions and community colleges. We also have a Faculty and Student Teams program that is aimed at developing long-term relationships between the faculty of small non-research institutions and the scientists at our national laboratories.

Of particular interest to us, is the proposed Laboratory Science Teacher Professional Development program. If our Nation is to have a sufficient number of physical scientists and engineers, we need to address the serious declines in these majors among U.S. citizens. A number of commissions and studies have shown that the best route to stimulating student interest is through qualified and exciting teachers especially in the middle school years. Our teacher professional development program is aimed at attacking this problem through mentor-intensive research and focused science-discovery experiences for K–14 teachers. It will forge long-term relationships between the national laboratory scientists and our Nation's science teachers. Through this approach we believe we can produce a group of teachers who will be agents of change and inspiration to their students and local educational communities. We believe this comprehensive plan will utilize the unique human and scientific resources of the national laboratories to help support the future science workforce development of the Nation.

Question. What is so different about your office's approach to High End Computing? What are you doing to develop this important area and what are the benefits?

Answer. There are three major differences to our office's approach to High End Computing. First, we will conduct this effort within the context of an inter-agency strategy in High End Computing, to leverage resources and to provide the strong, broad commitment needed to sustain this long-term strategy. Second, we will engage our scientists with computer design researchers and with U.S. computer vendors through research collaborations, to evaluate computer system bottlenecks and to identify cost-effective solutions. Third, we will support research in the software programming environment to ensure that future supercomputer platforms are easy to use as soon as they become available.

Question. What actions have you taken in the last year to assure the integrity of the Lab Directed Research and Development process?

Answer. The Office of Science implemented the following policy changes to ensure that the LDRD program at its laboratories is executed in full compliance with all Congressional and DOE regulations.

—My office issued detailed guidance on the roles and responsibilities for Headquarters, DOE Site Offices/Operations Offices and the Laboratories regarding adequate reporting and effective oversight of the LDRD program.

—For the first time in the Office of Science, I can personally assure you that a single Federal official—the site office manager—will carry out a prospective review of the laboratories' proposed LDRD projects, ensure their relevance to DOE missions and concur in each project.

—Also, my office developed supplemental implementation guidance for reporting LDRD charges on other Federal agency funded work for others (WFO) projects and it is being implemented by each Site Office.

—The Office of Science provided the necessary data to the CFO's office for the annual LDRD financial report to Congress. This report provides information and analyses to comply with congressional requirements, and supports the conclusion that the LDRD funds clearly benefit the national security missions of the Department by providing innovative new research to underpin future mission capabilities.

—In addition, each year the Science laboratories analyze and report the benefits provided to defense and non-defense customer categories as a percentage of total LDRD project dollars. They demonstrate that LDRD benefits are commensurate with the percentage of funds received.

I have made a personal commitment to ensure that we are fully responsive to Congressional guidance on LDRD and will strive to make our improved processes work efficiently and effectively.

ENERGY EFFICIENCY AND RENEWABLE ENERGY

Question. I see that you have zeroed out funding for the Concentrating Solar Power portion of the solar energy budget. I have been told by many energy scientists, including researchers at the National Renewable Energy Lab (NREL), that CSP holds significant promise for long-term energy potential. Why have you given up on Concentrating Solar Power and what is it going to take to get you to focus on it again?

Answer. EERE's budget reflects numerous factors: Administration priorities, alignment with the Administration's R&D investment criteria, program performance, expected public benefits, and bringing to completion research on some technology applications that are ready to be commercialized. Concentrating Solar Power was identified as a low priority area because of a study by the National Academy of Sciences in 2000 that recommended: "[The Department] should limit or halt its research and development on power-tower and power-trough technologies because further refinements would not lead to deployment." The study also suggested that the Department reassess market prospects for solar dish/engine technologies. Based on these recommendations, the fiscal year 2003 budget began phasing out the CSP program, and the fiscal year 2004 budget terminates it.

In 2002, the Department sponsored two independent technical reviews of Concentrating Solar Power: the first by Sargent & Lundy (S&L), an engineering firm that conducts due-diligence studies in the power sector; the second a review by the National Research Council (NRC) of the S&L study. In November 2002, the NRC submitted its review of the initial S&L study. The NRC found that many of the conclusions from the S&L study were reasonable, but also identified several limitations and deficiencies in the S&L analysis, which S&L has agreed to address. We are awaiting the final report from Sargent & Lundy, and based on our review of that

and the NRC review DOE will reevaluate the possibility of future Federal support for CSP.

Question. In the last two conference reports we have carried language directing the National Renewable Energy Laboratory (NREL) to deploy some of their technologies in Nevada in partnership with industrial and university partners. It is my understanding that this effort is working out well for everyone involved, but I would be interested in your thoughts.

Answer. Within the scope of this Congressionally-directed activity, DOE and NREL staff identified a variety of RDD&D opportunities in fiscal year 2002 that the indicated Nevada constituencies might conduct to complement existing renewable program efforts and provide benefits to Nevada and the U.S. Southwest. In response to a targeted solicitation, nine proposals were selected for award from among 36 proposals. Work on eight of the nine projects commenced in October 2002. The ninth project with Pulte Homes for a Zero Energy Home demonstration project/information center has been delayed due to the departure of Pulte's project lead. Alternate builders are being sought to support Pulte's end of the project and complete the award negotiations. With the fiscal year 2003 appropriations only recently concluded, no new awards have been made. In general, the implementation process is proceeding smoothly but it is too early to characterize the possible program technology and regional energy benefits that may result from this funding.

Question. Biomass seems to have taken a substantial cut in the fiscal year 2004 request. By all accounts this program has been very successful. Why are you cutting back at this time?

Answer. The Department recognizes the tremendous potential of a well-focused biomass R&D program to develop biorefinery technologies that can produce fuels, power, and high-value chemicals and other products. Nevertheless, Congressionally-directed activities reduced the coherence of this program and significantly constrained the ability of our scientists and engineers to move these important technologies forward. Thus, when we made the tough choices about funding the most important research for our Nation's energy security, environmental, and economic goals, we decided to shift funds from the biomass program where the effectiveness of our R&D work was already reduced into other areas, particularly our longer-term hydrogen and fuel cell R&D.

EERE's budget reflects numerous factors: Administration priorities, efficiencies realized by combining all biomass research under one program, alignment with the Administration's R&D investment criteria, program performance, expected public benefits, and bringing to completion research on some technology applications that are ready to be commercialized. It is also important to recognize that in fiscal year 2004, DOE will continue collaborating with USDA in order to leverage both agencies' resources as we are doing in fiscal year 2003. In fiscal year 2003, under a joint solicitation required by the Biomass R&D Act of 2000, USDA will award $14 million and DOE $5 million for cost-shared R&D work identified in the Act.

Question. When you took over as Assistant Secretary 2 years ago, you expended a substantial amount of time and effort in reorganizing the Energy Efficiency and Renewable Energy office. One of the unique features of the final organization chart was the creation of a Board of Directors for EERE. You assured us at the time that the Board of Directors was going to be a panel of your brightest minds and was going to be afforded the opportunity to think big thoughts and advise you directly. More to the point, you assured us that it was not a burial ground for unwanted Deputy Assistant Secretaries. However, in the year since the reorganization went into place, two of your five Directors have left and the other three seem to be engaged in activities not always directly related to your office's mission. Do you still stand by the concept of a Board of Directors?

Answer. One of the innovations of the new EERE business model has been the creation of the Board of Directors. It has also been one of the early successes. Board members have represented EERE and the Department in international climate change deliberations, formed corporate strategies related to the FreedomCAR partnership and Hydrogen Fuel Initiative, and advised on how to reshape the budget to comport with new, emerging priorities. Proof positive of the importance of this unique governmental entity is that we are conducting a national search to replace the recently departing Board members and hope to have an announcement as to their replacement in the coming weeks.

QUESTIONS SUBMITTED BY SENATOR PATTY MURRAY

SCIENCE

Question. Dr. Orbach, the Pacific Northwest National Lab (PNNL) and major Universities and research institutes in my State are valuable resources for the Genomes to Life program and I urge you to expand the use of those world class facilities. However, I also realize the Office of Science's Biological and Environmental Research program sustained real cuts into the base budget in the fiscal year 2003 Omnibus budget. For this budget year, I would like to work with the Chairman to include significant increases for the Genomes to Life program in the BER budget. Dr. Orbach, what would the Office of Science be able to do with additional funds for the Genomes to Life program?

Answer. Senator Murray, I believe that the fiscal year 2004 President's request for the Genomes to Life program provides robust funding, while balancing the needs of this exciting new program with other equally compelling programs being carried out within the Office of Science. In these very early days of research in the Genomes to Life (GTL) program we have three types of research needs. First, we need to fund large, multi investigator, multi institutional, multidisciplinary research teams to do the kinds of science required by a program whose technology, computational, and experimental challenges are as complex and diverse as those of the GTL program. We have already funded 5 large scientific teams ($5–7 million per year) whose research spans the four core goals of the GTL program (approximately one team per goal): (1) understand all the multi protein molecular machines in DOE-relevant microbes, (2) identify the genetic regulatory machinery that controls these machines, (3) understand complex, DOE-relevant communities of microbes since microbes generally work in communities and not alone, and (4) develop the computational resources needed to make all of this happen. To ensure a diversity of research approaches that is so important for fundamental discovery in science, we need at least two or more teams of scientists addressing each of these large, challenging goals. The fiscal year 2004 President's request includes an additional $29.2 million for GTL. These additional funds could, for example, support an additional large team of scientists focused on each of the four core GTL goals. Second, we need to fund a wide variety of cutting edge research projects that will help us develop many of the specific technologies and research tools that will be needed by our large GTL research teams, by planned GTL user facilities (see below), and, indeed, by tomorrow's scientists across all areas of biology. These individual investigator type projects are analogous to the many projects funded in the Human Genome Project that led to the development of the resources and technologies eventually used to actually sequence the human genome. Third, the proposed GTL plan calls for cost-effective, high throughput user facilities for carrying out much of the routine biology and generating the necessary resources of GTL (and for other areas of biology outside of GTL) just as the Human Genome project needed DNA sequencing factories. Four high throughput facilities are planned for (1) protein production, (2) imaging of microbial proteins, molecular machines, and communities, (3) proteomics, and (4) whole systems analysis.

Question. Dr. Orbach, does the fiscal year 2004 budget request have enough funds to have full utilization of EMSL including computer equipment?

Answer. The fiscal year 2004 budget request for the Environmental Molecular Sciences Laboratory (EMSL) includes $35,149,000 for operating expenses and $1,989,000 for capital equipment. The EMSL is expected to have sufficient funding to allow full utilization of the EMSL, including the new high performance computer.

SUBCOMMITTEE RECESS

Senator DOMENICI. And for all of you who came from the Department and others, thank you for being here.

Thank you.

[Whereupon, at 3:31 p.m., Wednesday, March 12, the subcommittee was recessed, to reconvene subject to the call of the Chair.]